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SOCIETY of MOTION PICTURE and TELEVISION ENGINEERS

In This Issue

NOVEMBER 1950

Society Business

With 4200 members and subscribers each receiving 12 *Journals*, over 60 Committee Meetings, 28 Section Meetings, 4 Meetings of the Board of Governors and 2 Conventions each year, plus the development and sale of test films at an ever increasing rate, your Society is assuming the proportions of a small but very active business. Details of operation are handled by a staff of ten people at the Headquarters office in New York City.

The Editor and one assistant turn out 1500 pages of *Journal* with two six-month indexes each year, plus all other publications, including test film catalogs, membership information and reprints, of which the best-selling "Principles of Color Sensitometry" is an example.

The Staff Engineer and his one assistant maintain all records of 20 engineering committees, and several subcommittees, prepare agendas, record proceedings and write, duplicate and mail minutes of over 50 technical meetings each year. They also coordinate a number of projects with other organizations and serve as Secretary pro tem of two Sectional Committees of the American Standards Association.

The Office Manager and three assistants maintain all business records in connection with memberships, subscriptions and test films, reporting monthly, quarterly and annually on the status of memberships as well as on all fiscal matters.

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Synthetic Color-Forming Binders For Photographic Emulsions

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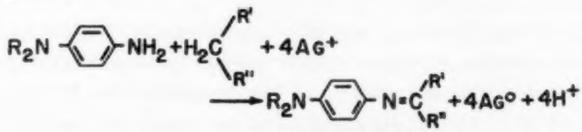
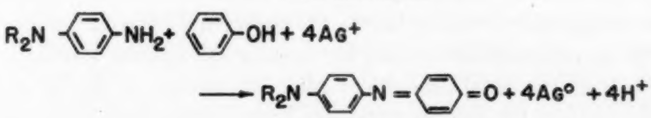
SUMMARY: The development of synthetic color-forming binders and their application to photographic emulsions is discussed. These accomplishments have made possible the manufacture of a release positive color film designated Du Pont Type 275.* A résumé of some of the novel features of the stock is given and the utilization of the material as a color release medium is covered. Details of the printing and processing of both picture and sound records are given.

One of the ways of creating a dye image in proportion to the latent image in a photographic film is known as coupling color development.† It was disclosed originally by Rudolph Fischer[1] in 1912. In fact, in 1914, Fischer and Siegrist[2] published the results of a thorough study of the chemistry involved, and disclosed several classes of reactions that could be used and suggested various photographic elements utilizing them. Of these classes of reactions, those useful in the formation of the azomethine and indophenol‡ dyes involved in the process to be described later can be represented by the following equations:



AZOMETHINE



INDOPHENOL

PRESENTED: October 11, 1949, at the SMPE Convention in Hollywood.

* The product on safety base is now designated Du Pont Type 875.

† It has also been called indirect color development, secondary color development, dye coupling development, and color-forming development.

‡ Properly called indoaniline dyes by the strictest chemical authorities, but almost always referred to as indophenol dyes in the photographic literature.

Although the exact mechanism of these reactions is still not completely understood, an oxidation product of the developing agent produced in the reduction of the exposed silver halide reacts in some way with the coupler to form the dye in direct proportion to the amount of silver formed. When the silver is removed, only the dye image remains.

In addition to comprehending the full possibilities of coupling color development, Fischer and Siegrist disclosed a broad picture of the various specific classes of developing agents and couplers that were applicable. Over the years this knowledge has been extended by numerous investigators.

Development of Synthetic Color-Forming Binders

Today there are commercial processes involving the application of the above reactions, for example, those in which the couplers are in developing solutions with the developing agent and those in which the couplers are in the emulsions. The former yields monochrome pictures readily, but three-color pictures only by rather complicated processing procedures. The latter readily yields three-color pictures, avoiding the cumbersome processing, provided the couplers are immobilized in their respective layers in the film. Such immobilization is necessary to avoid contamination of the various layers through wandering of the couplers.

The first solution to the coupler mobility problem came by placing substituents in the color coupler molecules in positions which did not affect the coupling power or quality. Although a reasonably high solubility in alkaline solutions was retained, these substituents increased the molecular dimensions of the couplers considerably and thus reduced the rate of diffusion from one layer to another to a tolerable amount. Such a system thus utilizes three chief components in its emulsions: (1) silver halide, (2) binder and (3) coupler.

The newest method devised for overcoming coupler mobility, and one that at the same time offers other advantages, is the use of synthetic binders for the photographic silver halides which are at the same time couplers. Such binders make possible the complete elimination of gelatin from emulsions useful for color photography. Since the color-forming groups are a part of the binder, the use of a third component in addition to the gelatin and silver halide of the basic black-and-white emulsions is not necessary.

CHEMICAL ASPECTS OF COUPLING COLOR DEVELOPMENT WITH SYNTHETIC POLYMERIC BINDERS

It will be recalled from experience in the handling of black-and-white films that the development of the photographic image, unlike many familiar chemical reactions, is not an "instantaneous" process. This is because in addition to the time required for diffusion of the developer solution throughout the emulsion layer, the act of development itself is regarded as a surface reaction taking place at the interface of the emulsion grains and the liquid developer solution.

In coupling color development the situation becomes still more complex because a third reacting species, namely, the color coupler, is involved and because the developing agent itself, after becoming partially oxidized in the development step, must then undergo a second reaction with the color coupler. Before this second process can occur, however, it becomes necessary for the partially oxidized developer to move about in search of coupler molecules with which to react. It is because of this sequence of steps in the color coupling process that the dye deposits may not reside in the immediate locale of the developed grains of silver but rather in a diffuse cloud nearby. It has been noted earlier that Fischer's early work in this field had been extended with a variety of techniques for making monomeric color couplers immobile in emulsion layers. Under such circumstances, however, the bulk of the coupler may be situated at some distance from the silver halide grains, making it necessary for migration of the intermediate reaction products of the color developer to take place. As a consequence, reaction with coupler molecules may occur diffusely in the vicinity of the grain, rather than in a concentrated zone at the surface of the grain. Furthermore, during the migration of the partially oxidized developer molecules, secondary reactions may occur, thereby reducing still further the efficiency of the over-all process.

The utilization of chemically combined color coupling nuclei in a polymer molecule simplifies the process of coupling color development. Since the synthetic polymer is the sole emulsion binder in a given emulsion layer, and since the polymer contains an abundance of color coupler nuclei as part of its chemical structure, high efficiency in the process of color coupling is achieved. A practical consequence of achieving high efficiency in dye generation is an enhanced compactness of dye-image deposit as defined by the silver image itself. Definition and sharpness of image in three-color prints is apparent as a result.

THE APPLICATION OF SYNTHETIC COLOR-FORMING BINDERS TO COLOR PHOTOGRAPHY

The successful utilization of the principle of dual-purpose emulsion binders has resulted in the development of a new motion picture color positive stock designated Du Pont Type 275. As one would expect, the evolution of a photographic color process based entirely on the complete replacement of gelatin with synthetic polymers has involved a variety of complex research problems.

At the outset, it was necessary to undertake the chemical synthesis of polymeric materials having properties permitting their use in place of gelatin, the traditional photographic emulsion medium. Up to this time, no completely satisfactory non-gelatin materials had been developed, even for application in the black-and-white field. In addition to properties permitting their use as emulsion media, the further requirement was imposed upon the new polymers that they must function in the capacity of couplers for use in a process of color photography. Three different color-forming binders were in fact required, each capable of producing a different subtractive color component, yet having related qualifications for the other important role.

The complex chemistry of these new polymers, while a broad subject in itself, is being touched upon only briefly in this paper because of limitations of space. For those to whom this subject is of interest, further treatment is to be given elsewhere.*

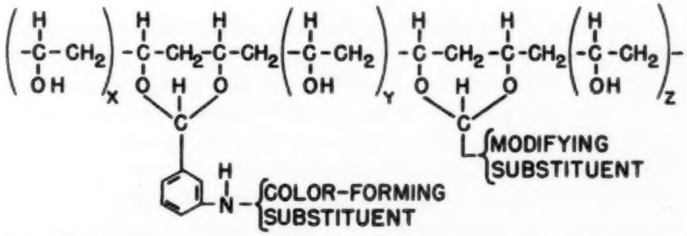
Having produced synthetic color-forming binders, a second essential step leading to the construction of a color film product was the development of methods for making the emulsions and for coating the new materials. In a number of significant respects, the technology which emerged differs markedly from practices which have become conventional for gelatin systems.

The new synthetic color-forming binders, in general, satisfy the exacting requirements for the medium in which the photographic silver halide is suspended. These requirements have been generalized by Mees[3] as follows: "It must keep the emulsion grains perfectly dispersed to eliminate clumping and consequent granularity of the photographic image; it must be stable for a long period of time, so that both the undeveloped and the processed emulsion are reasonably permanent; it must impart no undesirable photographic characteristics to the emulsion grains; it must be such that it can be handled in a relatively simple and yet accurately reproducible manner, so that emulsions can be made and coated by practicable procedures; and,

* This portion of the work has been carried out mainly in the Experimental Station Laboratories of the Chemical Dept., Wilmington, Del.

finally, it must allow the penetration of processing solutions without impairment to its strength, toughness, and permanence after the processing operations are completed."

While a number of synthetic binders, including polyvinyl alcohol, have been studied as replacements for gelatin, those which have proven practical for color emulsions are acetals of polyvinyl alcohol. Commercial methods have been developed for the manufacture of those selected for use. The coupling and other groups introduced by acetalization modify the properties of the parent polyvinyl alcohol to the extent that practical binders result. A typical structural unit for a synthetic color-forming polyvinyl acetal binder can be represented:



It is to be kept in mind that any coupling nucleus and developing agent that gives a dye of suitable color characteristics can be chosen, since mobility of the couplers and solubility of the final dye is not a problem. Also, while the coupling groups are very close to the site of the development reactions, the rate of reactivity is influenced by the coupling nucleus; so that this factor remains important in their selection. This latter is particularly important in multilayer structures where lower layers are less accessible to processing solutions than the upper layers.

Although the new technique quite nicely avoids some of the problems previously involved in coupling color development, it introduces new problems in the manufacture of photographic products. Gelatin, although having certain disadvantages, has some properties very useful to the photographic emulsion maker. These are its ability to form thermally reversible gels at convenient temperatures, and its contribution to the establishment of suitable photographic properties. So far, it has been difficult to synthesize binders that combine these properties so that, if the step were desirable for some other reason, the synthetic binder could be substituted directly for gelatin. Nevertheless, it has been possible to devise a technology for making and handling photographic emulsions and films utilizing the polyvinyl acetal color-forming binders.

In the making of a photographic emulsion the first step establishes the physical characteristics of the silver halide grains. This involves precipitation of silver halides in the presence of the binder, or part of it, and changing the size distribution of the grains by an operation in which the larger grains grow at the expense of the smaller ones.

It is next necessary to wash the emulsion to remove soluble reaction products of the first step which cannot be tolerated in the finished film. The reaction involved in the precipitation can be very generally stated as being silver nitrate plus alkali metal halide yielding silver halide and alkali metal nitrate:

$$AgNO_3 + MX \rightarrow AgX + MNO_3$$

where the alkali metal nitrate (MNO_3) represents the reaction product which must be removed. In gelatin technology it is the custom to chill the emulsion so that it forms a firm gel and in this state reduce it to small pieces by physical means, thereby increasing the amount of surface. The small pieces can then be leached with cold water to remove the undesirable reaction products which are extremely soluble in comparison to the silver halides. Since the new synthetic color-forming binders do not readily form gels in the manner of gelatin, it has been found convenient to devise chemical procedures for precipitating the emulsions and washing them.

In addition to being a necessary step in the handling of gelatin emulsions, the maintenance of the emulsions in the chilled state is necessary to slow down the rate of decomposition of the gelatin, which is a material so susceptible to putrefaction under some conditions that preservatives in addition to the chilling are required to make the procedures practicable. The new synthetic color-forming binders are by their chemical nature free of this difficulty.

After removal of the undesired by-products, the emulsion is ready for its final treatments before coating. With gelatin emulsions the washed pieces are melted by the application of heat before proceeding with the finishing treatments. With the new synthetics, the washed emulsion is simply redissolved. The actual finishing operations themselves, including extra-sensitizing procedures, addition of sensitizing dyes where needed, adjustment of pH, addition of wetting agents, etc., are strictly comparable for the two systems.

In the coating and drying operations necessary for applying the finished emulsions to film base, the differences between the two systems are again very apparent. With gelatin emulsions, the applied layer is chilled immediately after coating to form a firm gel and gradually dried from this gel state. The solidification procedure is

necessary to prevent flowing of the thin layers with formation of an uneven and nonuniform coating. With the new synthetic color-forming binders, chemical procedures have been devised for coagulating the emulsion to a nonfluid state before drying begins. This has been accomplished by treating the base suitably at the time it is made.

PHYSICAL CHARACTERISTICS OF SYNTHETIC POLYMERIC BINDERS

During the work on development of the synthetic color-forming binders and their application in Du Pont Type 275, it became apparent that the new polymers could confer upon a photographic product a number of unusual physical characteristics, not all of which were visualized at the outset. Some of these properties may have important technical significance in the future, and they will be reviewed before discussing the properties and performance of the stock itself.

Brittleness and lack of flexibility, particularly at low humidities, are well-known properties of gelatin. In contrast, the synthetic polymers which have been discussed exhibit a high degree of flexibility, toughness and resistance to abrasion. A composite polymer monopack structure, for example, composed only of functional photographic layers, each a few ten thousandths of an inch thick and having a total thickness of only 0.001 in. can be shown to be strong and self-supporting after solvent removal of the base support.

In an experiment such as that just described, and in analogous treatments with a variety of solvents, it is apparent that the developed dyes as well as the color-forming binders are polymeric and accordingly completely insoluble. Thus, problems in connection with waxing, cleaning or polishing operations will be minimized. The tendency of gelatin to respond rapidly to thermal changes is apparent to a much lesser degree in the case of the synthetic polymers. While the implications of this property have not been fully explored as yet, one advantage that may accrue is processing at elevated temperatures.

STRUCTURE OF DU PONT TYPE 275

Du Pont Type 275 is a monopack subtractive color film having all dye-generating layers superposed on one side of the support and requiring no stepwise processing or transfer operations. It utilizes cyan (minus-red), magenta (minus-green), and yellow (minus-blue) synthetic color-forming binders of the type discussed above. The structure is shown in Fig. 1. The functions of the various layers on the base are as follows:

1. The top emulsion layer, unsensitized to other than blue light, receives the magenta image from the green analysis record by printing

with blue light. The yellow dye that is present and which distributes itself throughout the film absorbs the blue light as it passes through and prevents it from exposing the bottom layers which, since they contain silver halides, are also blue-sensitive. The yellow dye dissolves out during processing.

2. The separator layers prevent interlayer effects, not those usually caused by migration of the coupler molecules, since in this film these have been immobilized by making them an integral part of the binder, but those caused by migration of oxidized developer molecules between adjacent layers.

3. The middle emulsion layer, sensitized only to red light in addition to its inherent blue sensitivity, receives the cyan image from the red analysis record by printing with red light.

Fig. 1. Structure of Du Pont Type 275 Color Film, Release Positive.

4. The bottom emulsion layer, sensitized only to green light as well as retaining its inherent blue sensitivity, receives the yellow image from the blue analysis record by printing with green light.

5. The substratum layers anchor the emulsion and backing layers to the film base.

6. The antihalation backing coated on the rear of the film absorbs any light passing through the emulsions into the base, so that it cannot be reflected from the back surface of the film and cause halation. During development the backing dye is decolorized, and later on, during the washing steps, the entire backing layer dissolves off spontaneously without mechanical scrubbing. The spectral absorption of the backing is shown in Fig. 2, there being ample density at all wavelengths where protection from halation is required.

It is to be noted here that the layers other than the emulsion layers

are also prepared using synthetic polymers, thus completely eliminating gelatin from a commercial photographic product. The physical properties, such as water sensitivity and swelling, of all the different polymers used have been balanced in order to make a film of satisfactory characteristics. At the same time, the permeability of the layers

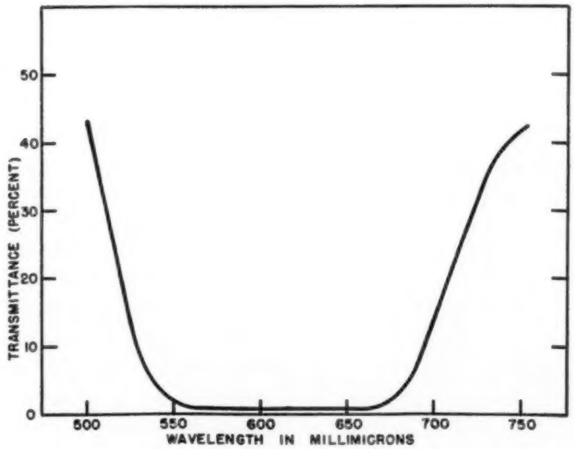


Fig. 2. Spectral absorption of the antihalation backing.

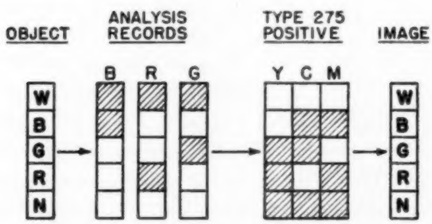


Fig. 3. Color reproduction with Du Pont Type 275.

B = Blue	C = Cyan	G = Green	M = Magenta
N = Neutral	R = Red	W = White	Y = Yellow

to processing solutions has been maintained at a high level in order to keep the lag between the start of development in the outermost layer and the lower layers at a minimum. Fortunately, the physical properties of the synthetic color-forming binders can be balanced by adjustment of the number of color-forming nuclei present and by the introduction of other groups.

Fig. 4. Wedge spectrogram showing sensitivity peaks of magenta, yellow and cyan layers.

PHOTOGRAPHIC CHARACTERISTICS

Since this film is designed for printing from color separation records, it is possible to have a layer arrangement and sensitivity as shown without regard to the kind of light originally required to make the various records. This is explained in Fig. 3. The arrangement chosen has been adopted in the interest of resolution (sharpness) with the various images positioned in order of importance, namely, the green-record image in magenta on top, the cyan (red-record) image next and the yellow (blue-record) last.

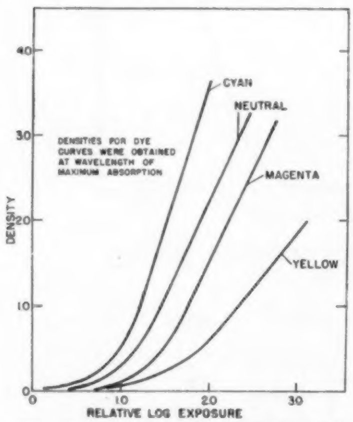


Fig. 5. Sensitometric curves for individual layers and neutral scale.

A wedge spectrogram showing the spectral response of the complete film is shown in Fig. 4. This shows peaks at 440, 550, and 710 mμ (millimicrons) for the magenta, yellow and cyan layers, respectively. The peak at 440 mμ in the magenta layer is produced by the instrument used, the peak for the silver halide used actually being at about 390 mμ.

Photographic characteristics have been adjusted to permit printing from color analysis records having equal effective contrasts. The sensitometric curves of the various layers for a standard set of developing conditions using the developing agent *p*-aminodiethylaniline are shown in Fig. 5, with densities measured at the wavelength of maximum absorption of each dye. A similar set of curves was selected as a goal of the work by calculations made from a neutral sensitometric curve of desired characteristics (gamma = 2.5, straight-line densities to 2.8) and the absorption characteristics of the dyes from the color-forming binders selected for use. The absorption curves of

the various dyes and their contributions to a neutral density of 1.0 are given in Fig. 6.

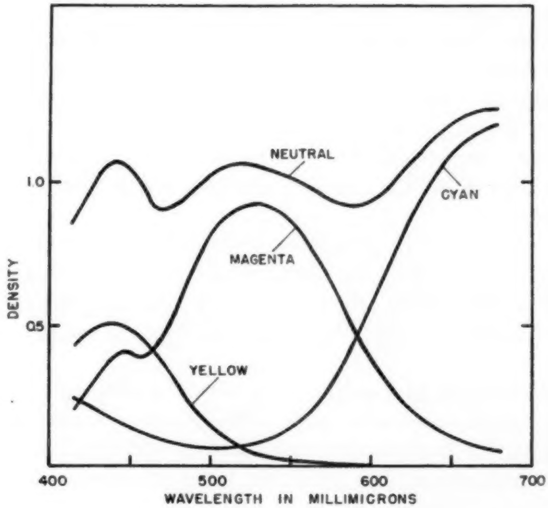


Fig. 6. Spectral characteristics of component dyes and resulting neutral.

PRINTING DU PONT TYPE 275 COLOR FILM

To make pictures on Du Pont Type 275 Color Film, Release Positive, three-color separation negatives must be printed onto the one release film in such manner that the positive image of each color separation is recorded only in the proper dye-generating layer. Naturally the three dye images in each frame must be superimposed in register. Because of the complex nature of the stock, only limited variation of contrast can be achieved in processing, so the primary control of contrast and balance lies in adjusting the contrast of the negatives. These requirements mean, for the present, that Type 275 must be printed in a register printer from three black-and-white separation negatives, each printing exposure being made through a narrow-pass filter so that the image will be confined to the appropriate subtractive color.

Any black-and-white three-color separation negatives may be used to print Type 275 provided they have the following characteristics:

1. Proper color separation;
2. Correct orientation for same-side printing;
3. Good register;
4. Acceptable sharpness;
5. Reasonably fine grain;
6. Appropriate contrast.

Negatives meeting these specifications may be derived from such existing or proposed methods as: stripping film, beam-splitting cameras, filter-wheel cameras, and separations from monopack color films.

To amplify these characteristics somewhat, the first means that each separation must record only the intended color aspects of a scene. The red negative, for example, must not respond to blue or green in addition to red, otherwise color degradation will result. Most directly exposed negatives meet this requirement quite well. Separations from color positives are often acceptable, but may be improved by masking.

Correct orientation for one-side printing requires the mirror-image reversal of at least one of the negatives obtained with beam-splitting cameras or stripping film. Since this can be done in optical printers of the type commonly used in the industry, this is usually no problem.

The requirements of good register, acceptable sharpness, and fine grain are common to all color work. The excellent resolving power of Type 275 emphasizes the need for good register and fine grain, because there is almost no diffusion of the image to cover up poor register or coarse grain in the negatives.

Figure 7 illustrates the contrast requirements for negatives to be used with Type 275. It shows a comparison between a black-and-white fine-grain release positive and the gray-scale or "equivalent" density characteristic curve of the color film. A black-and-white print with full tonal range may encompass the densities 0.15 to 2.3, which correspond to a density range of 1.1 in the negative. In the case of color films, experience shows that the density range in the print is typically somewhat greater, perhaps 0.15 to 2.8. The density scale in the negative must be correspondingly somewhat higher, about 1.45, which is 1.3 times as great. Thus, while negatives for black-and-white use typically have a γ of 0.65 to 0.7, negatives for contact printing of Type 275 should be at γ 0.85 to 0.90. This factor 1.3 is almost exactly the gain in contrast of projection printing compared with contact printing. Thus, negatives of the same contrast as normally used in black-and-white practice may be printed optically on Type 275.

Inasmuch as the contrast of the new color film is subject to only relatively small adjustment via processing, the gamma of the negatives is the major variable by which the contrast of the final image may be controlled. If negative gamma is not appropriate to begin with, it will be necessary to alter it by duping.

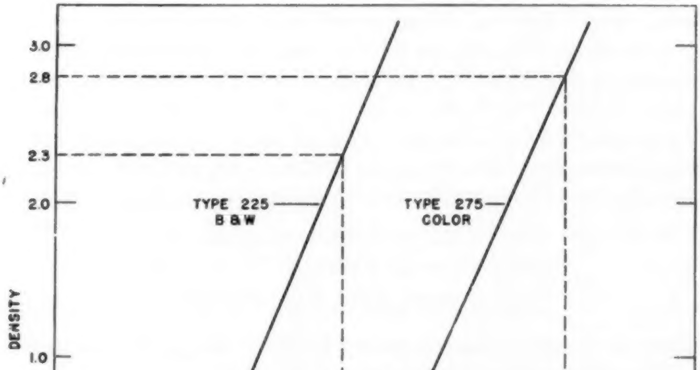


Fig. 7. Comparison of H&D curves for color and black-and-white positives, illustrating contrast requirements for negatives.

Exposing Filters

Having obtained a suitable set of separation negatives, the next step is to expose each record into the proper emulsion layer of the print film. Figure 1 has shown the relation between the spectral sensitivity of each layer and the dye generated in that layer by color development. The top layer is blue-sensitive and forms the magenta dye, thus it must be printed from the green-record negative. The middle layer is sensitive to red light and its image is cyan; so it is exposed from the red-record negative. The bottom layer develops yellow; so it receives the blue-record image by printing with green light, to which the layer is sensitive. The color sensitivity of each layer bears no required relationship to the color of the subtractive dye it carries, for it is simply a means of confining each exposure to the proper layer. The proper exposing color is obtained by using a narrow-pass filter over the light source.

The wedge spectrogram (Fig. 4) shows the spectral region to which each layer is sensitive, aiding the selection of exposing filters. Sensitivity of the top, magenta-forming emulsion extends from the ultra-

violet to about 490 mμ. The response of the green-sensitive emulsion begins at about 495 mμ, so, clearly, the blue filter must cut off at wavelengths shorter than this value. The green sensitivity extends to about 590 mμ, with a peak at 550 mμ. The red sensitivity begins at 600 mμ and peaks at 710 mμ. The selection of practical filters involves finding ones with maximum transmissions of the desired colors and minimum leak of undesired wavelengths. The most efficient set is:

Blue—Corning 5113, half-thickness;
Green—Defender 60G;
Red—Corning 2403, full-thickness.

There is enough variation among filter batches so that individual filters should be checked photographically, or on a spectrophotometer. Similarly, filters in production use should be checked from time to time for constancy.

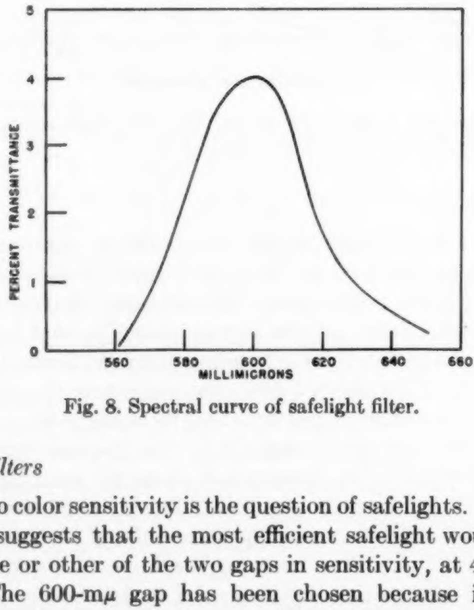


Fig. 8. Spectral curve of safelight filter.

Safelight Filters

Related to color sensitivity is the question of safelights. Re-examining Fig. 4 suggests that the most efficient safelight would transmit freely at one or other of the two gaps in sensitivity, at 495 mμ or at 600 mμ. The 600-mμ gap has been chosen because it is a little wider. A spectrophotometric curve of the safelight filter designed for this film is shown in Fig. 8. An infrared-absorbing component is desirable in the safelight, because the cyan layer has considerable infrared sensitivity to wavelengths which most organic dyes begin to transmit rather freely. With the filter illustrated, a five-minute ex-

posure is safe with an illumination of 0.02 ft-c. While this is not quite as bright as safelights commonly used with black-and-white positive, it is very bright indeed for a film having essentially panchromatic sensitivity.

It is interesting to note in passing that a monochromatic source emitting the wavelength of one of the gaps in sensitivity would make a very efficient safelight indeed. Although the "D" lines from a sodium arc do not fall quite at an ideal wavelength, they do produce very high illumination for a given level of "safety."

Printing Equipment and Illumination Requirements

A registration printer, either optical or contact, is required for exposing the picture images onto Type 275, because this operation involves three successive printings from separation negatives. Any conventional printer of this class may be used; the only additional specification over black-and-white printing is that filters must be placed between the light source and film.

Any standard light-change device may be used. These include traveling mattes, apertures, and lamp voltage control. It should be noted in the latter connection that perfect freedom is permissible in varying lamp voltage. Since the exposures are made through narrow-pass filters, this process does not require that the source be operated at a fixed color temperature. Whatever the mechanism, it is desirable to have fine printer-point steps to give maximum control over color balance.

Regarding illumination requirements in the printer: a 500-w incandescent lamp 10 in. from the film plane, with spherical mirror, in a contact printer with 1/10-sec exposure time gives ample exposure.

PROCESSING DU PONT TYPE 275 COLOR FILM

Processing of Du Pont Type 275 Color Film consists of four chemical treatments, with water washes or rinses between. The steps are shown in Table I.

TABLE I. Processing Steps for Du Pont Type 275 Color Film.

1. Develop	10–12 min	6. Wash	4 min
2. Wash	1–2 min	7. Second fix	4 min
3. First fix	6 min	8. Wash	10 min
4. Wash	5 min	9. Dry	—
5. Bleach*	5 min		

* Note: If sulfiding of track is employed, this may be done after a 1-min wash following Step No. 5. Processing then proceeds to Step No. 6.

After the film has been exposed in the printer, it is developed in a color developer. Here a silver image is developed in each layer, and concurrently the final dye images are also generated. Following a wash, the film passes to the first fixer, where all silver halide not used in the primary image is dissolved. The next treatment is a bleach which converts the silver image to silver ferrocyanide, which is dissolved by the second fixer. If the sound track is to be sulfided, this may be done following the bleach, before the second fix. Water washes are necessary between chemical treatments to avoid excessive contamination of one solution with another, which might lead to shortened solution life and the possibility of stain on the film. As with other films, a final wash is used to remove all processing chemicals from the emulsions. Drying is accomplished in the usual manner.

The processing times given in Table I are based on 70 F solution temperatures. While the temperature of the developer should be held quite constant ($\pm \frac{1}{2}$ deg) for uniform results, temperature control is not particularly critical in the subsequent steps, since the reaction in each treatment is to be carried to completion.

Temperatures other than 70 F may be used if more convenient. Higher temperatures lead to shorter processing times, and may be very desirable in cases where machine capacity is limited. Type 275 has been processed successfully with all solutions at 90 F or above, without the need for special hardening treatments.

The times listed in Table I for processing steps beginning with the first wash have been selected as the minimum, in the interest of developing-machine compactness. Additional treatment time is permissible if machine capacity is available, and would provide a wider safety factor to assure complete reaction.

Processing Solutions

Table II gives formulas of solutions for processing.

The developer formula given in Table II should be considered approximate, and may vary for individual processing machines, depending upon conditions of agitation, etc. The reason for this is evident from a consideration of the complex structure of the film. It is obvious that the three emulsion layers do not have the same accessibility to developer, image formation naturally progressing more rapidly in the upper layers, which the developer reaches first. Thus, proper contrast balance to give a gray-scale is achieved only under a restricted range of processing conditions. Over-all contrast cannot be altered significantly by a simple change of development time as in black-and-white film, because a departure from the proper developing

time, with no other compensating change, throws the contrast relations of the three layers into incorrect balance. Since different developing machines do not give identical results, some adjustments may be needed to obtain a balanced development.

In general, the composition of processing solutions, particularly the developer, must be maintained to closer tolerances than are allowable in black-and-white photography. It is imperative that replenishment be based on accurate analytical techniques. It is recommended that the developer be replenished continuously, though the other solutions, which have wider tolerances, may receive batchwise additions of replenisher. Analytical techniques are available, but their description is outside the scope of this paper.

TABLE II. Formulas for Processing Type 275 Color Film.

Developer		*First Fixer*	
p-Aminodiethylaniline Monohydrochloride	2.5 g	Hypo, crystals	240 g
Sodium Sulfite, anhyd.	10.0 g	Sodium Sulfite, anhyd.	15 g
Sodium Carbonate, monohyd.	47.0 g	Borax	18 g
Potassium Bromide	2.0 g	Acetic Acid, 28%	43 cc
Water to make	1.0 l	Potassium Alum	20 g
*p*H = 10.5 (approx.)		Water to make	1 l
		*p*H = 4.5 (approx.)	
		For use: dilute 1 part solution to 2 parts water	
Bleach		*Second Fixer*	
Potassium Ferricyanide	100 g	Hypo, crystals	200 g
Boric Acid	10 g	Water to make	1 l
Borax	5 g	*p*H = 8.0 (approx.)	
Water to make	1 l		
*p*H = 7.0 to 7.5			

Processing Machine Design

Figure 9 illustrates a form of continuous developing machine for Type 275 Color Film. The sketch is schematic and is intended to suggest only the proper tank arrangement. As far as details of design and construction are concerned, this particular process does not necessitate any features different from good black-and-white practice. In fact, a black-and-white machine may be converted provided it has enough tanks to allow proper arrangement of solutions.

SOUND TRACKS

Sound reproduction problems peculiar to multilayer color films with dye-image tracks have been the subject of several papers in the JOURNAL. Special techniques have had to be developed for dye-image sound tracks, for it is now generally recognized that they cannot be used directly with the red-sensitive phototubes which are now standard for theater motion picture projectors.[4] It is the universal characteristic of organic dyes suitable for three-color images that they are quite transparent in the near-infrared spectral region to which the 868 phototube has its greatest response. The result of trying to use such a combination inevitably is weak modulation and poor signal-to-noise ratio.

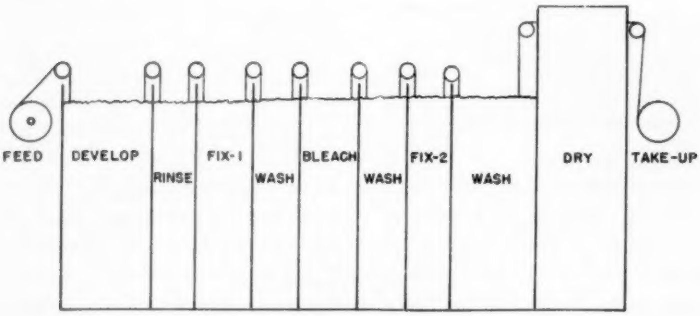


Fig. 9. Schematic arrangement of processing machine.

Two solutions to this dilemma have been found. One is to use a magenta-dye sound track in conjunction with a phototube with an S-4 photosurface.[5,6] The spectral response of such a phototube when illuminated with a tungsten lamp has its peak at about 530 mμ, which is near the maximum absorption of the magenta dye. Thus, variations in magenta density modulate the phototube strongly. A second solution is to convert the silver image formed in the sound track during development into silver sulfide, which is relatively non-transparent in the near infrared, hence can be used with standard red-sensitive phototubes. Both of these methods can be utilized successfully with Du Pont Type 275 Color Film. The former has the advantage of simplicity, for it requires no extra treating steps; it also has certain technical superiorities. The latter has the advantage of expediency; it yields tracks which may be played with the present, existing phototubes.

Magenta Sound Tracks

When a phototube with S-4 sensitivity is to be used for reproduction, a sound track is applied to Type 275 Color Film in a manner completely analogous to black-and-white practice. The sound negative is simply printed on the color positive using the blue-exposing filter to confine the image to the magenta-forming emulsion, and the film is developed as described without any additional treatments to the sound track.

The top density and contrast of the magenta image, while dictated by picture requirements, are quite appropriate for sound reproduction. In particular, the high resolving power of the magenta emulsion confers good high-frequency response to a magenta track.

Because the contrast of the magenta image as "seen" by a blue-sensitive phototube is somewhat lower than black-and-white release positive, variable-density negatives intended for printing on Type 275 should have somewhat higher contrast than is used with black-and-white positive. A Du Pont Type 228 negative developed to a IIB control gamma of about 1.2 will yield a magenta track with minimum intermodulation for positive track densities in the neighborhood of 0.6 density. Likewise, variable-area sound negatives should have higher track density than if intended for black-and-white use. In cross-modulation tests a magenta track, printed from a Du Pont Type 201 negative developed to a IIB gamma of 3.5 and having a track density of 2.5, had optimum cancellation for a 1.15 density.

Actual intermodulation data for magenta sound tracks are represented by the solid curve of Fig. 10, and cross-modulation data appear in Fig. 11. These distortion measurements were made with a 1P37 phototube in the sound reproducer, and the track densities read with a blue-sensitive phototube in the densitometer.

Sulfided Sound Tracks

A sulfided sound track is produced on Type 275 by an edge treatment following the bleach, but preceding the second fix. At this point in the processing the original silver image has been converted to silver ferrocyanide by the bleach. This compound reacts very rapidly with sodium sulfide to form silver sulfide, which has the desired opacity to near-infrared radiation.

The picture image also contains silver ferrocyanide, so it is obvious that the entire film should not be treated with sodium sulfide. Therefore, an applicator which treats only the sound track with the sulfiding solution must be used. Such applicators are not novel, and many

forms have been used successfully. To keep the solution from diffusing to undesired areas, its viscosity is raised by the addition of a thickening agent.

Sulfiding Solution

Distilled water (125 F)	750 cc
Sodium Carboxymethylcellulose, medium viscosity	20 g
Sodium Sulfide, nonahydrate	63 g
Water to make	1 l

Stir thoroughly with a mechanical stirrer and filter while hot. Cool to room temperature before using.

The film should receive a 30- to 60-sec water rinse following the bleach bath to eliminate excess ferricyanide solution. At this time, the film is removed from the machine and prepared for the sound-track beading operation. An air blow-off should be used to remove excess liquid from the surface of the film. Best results are obtained when the emulsion is partly dried by passing the film through a drying chamber.

The film travel is so arranged that a developing time of one full minute is allowed following the application of the sulfiding solution. At the end of this period, the sound track area is subjected to a small, high-velocity water stream directed to wash the treating solution toward the perforations. This removes the excess sulfiding solution. The film is now returned to the machine for completion of the normal process, the next treating bath being the second fix.

Sound tracks to be sulfided are exposed in a slightly different way than are magenta tracks. While it would be desirable from the point of view of sharpness to print the track in the top layer only, the amount of silver in the magenta emulsion alone is too low to produce a silver sulfide track of the desired density. Thus, it is necessary to utilize the lower emulsions by printing with white light, even though some loss of high-frequency response results.

The following operating conditions were found at the Du Pont laboratories to give satisfactory results. A variable-area negative recorded on Du Pont Type 201 Sound Recording film was exposed to give a negative track density of 2.5 with the film processed to gamma 3.5. This track was printed onto Type 275 with unfiltered incandescent light and sulfided as described. Cancellation of 30 db or more occurred at positive track densities in the neighborhood of 1.2. A variable-density sound negative recorded on Du Pont Type 226 processed to a IIB gamma of 1.5 yielded a color sound print with minimum intermodulation at positive track densities about 0.6.

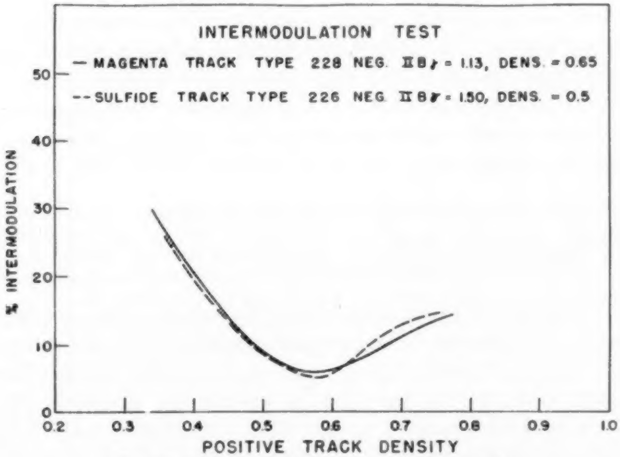


Fig. 10. Intermodulation curves for magenta and sulfide variable-density sound tracks.

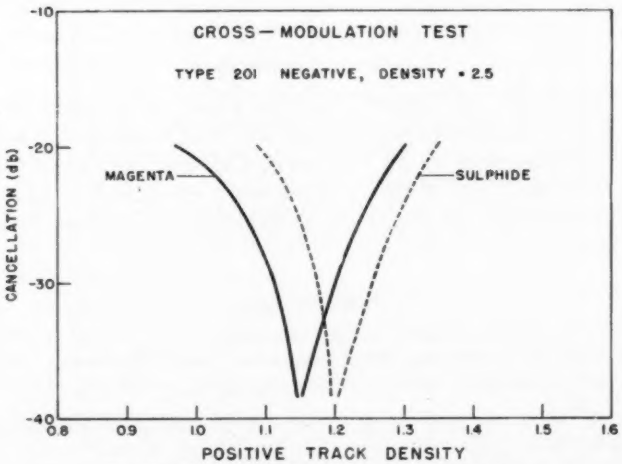


Fig. 11. Cross-modulation curves for magenta and sulfide variable-area sound tracks.

The dashed curves in Figs. 10 and 11 show actual intermodulation and cross-modulation data, respectively, for sulfided sound tracks played with a standard 868 phototube. The track densities likewise were measured with a red-sensitive phototube as the receiving element of the densitometer.

Volume output of both magenta and sulfided sound tracks is normal, being within 1 or 2 db of a standard silver track. Signal-to-noise ratio is somewhat better than black-and-white positive, attributable to the exceedingly fine grain structure of the colored image. Following are typical signal-to-noise ratios comparing the three types of track for variable-area recording without noise reduction:

Fine-grain Release Positive (black-and-white).	36 db;
Type 275 magenta track (1P 37 cell)	38 db;
Type 275 sulfide track (868 cell).	40 db.

High-frequency reproduction with color sound tracks is somewhat inferior to silver tracks. This is particularly true of sulfided tracks. The loss is caused partly by the high negative track density requirement and partly by the fact that a sulfided track utilizes all three of the emulsion layers of the color film. At 9000 cycles a magenta variable-area track is about -2 db from a silver track, while the sulfided track is about -7 db from the silver reference. Some high-frequency boost during recording may be necessary with the latter combination.

ACKNOWLEDGMENT

The developments reported in this paper were made possible through the combined efforts of many Du Pont research workers. In addition to the work in the laboratories of the Technical Division, Photo Products Dept., Parlin, N.J., extensive contributions have been made by the Chemical Department, Experimental Station, Wilmington, Del.

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An Improved Video System For Television Studios

By NEWLAND F. SMITH

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SUMMARY: A new video system and a new arrangement of television studios have been devised at WOR-TV. This system adds considerably to the flexibility of a television station by permitting combination of any of the station's cameras in any combination in several studios for programming. This is accomplished by using a separate "camera control center" where all camera control operations are carried out. Individual studio control rooms provide for program direction and switching of the cameras for a particular program.

In designing a television studio system at the present time the primary consideration is to make the whole system as flexible as possible—first, because television broadcasting is still a relatively new art, and therefore constantly changing as new ideas are developed; and second, because program requirements for television shows vary constantly from day to day, each program making different demands on the technical facilities.

Purposing to make a television studio as adaptable as possible in all its phases, the Television Engineering Department of WOR proceeded with the design of its new television studios, located on West 67th Street in New York. The arrangement of the studios in this building incorporate several novel ideas, of which we shall discuss here the separation of the camera control operators from the program direction and switching center.

The camera control operators for all studios are centrally located in one room called the Camera Control Center. Thus the program director is not distracted by having to look over the shoulders of the technical operating personnel or by any confusion arising from their being in the same room.

In this system the program director has directly in front of him, at his console, monitors on each of his local cameras, plus two preview monitors for switching up the cameras from some other source which might be cut in to his program. In addition, the switching control panel is located on this desk for the video switcher who sits beside the program director.

By centrally locating all camera control units in one place, further

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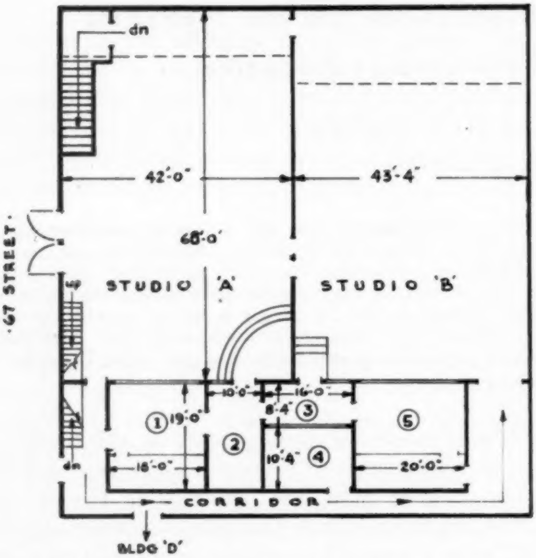

Fig. 1A. Floor plan of first floor showing studios and control rooms; (1) Control Room A, (2) Announce Booth D, (3) Announce Booth E, (4) Control Room C, and (5) Control Room B.

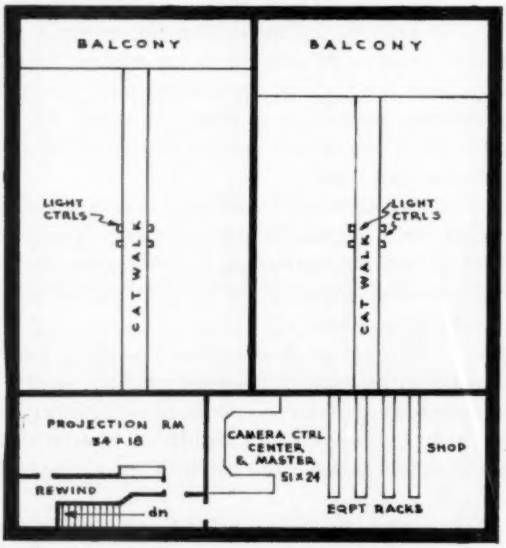

Fig. 1B. Floor plan of second floor showing projection and master control rooms and upper part of studios.

advantages from a technical point of view are realized. First, maintenance operations on the equipment are no longer hampered during rehearsal and program periods by the presence of program personnel in the same room, and, in case of trouble, replacement of equipment in the Camera Control Center is greatly facilitated. Secondly, the flexibility of operation is greatly increased. For example, any combination of the eight studio cameras and three film cameras can be

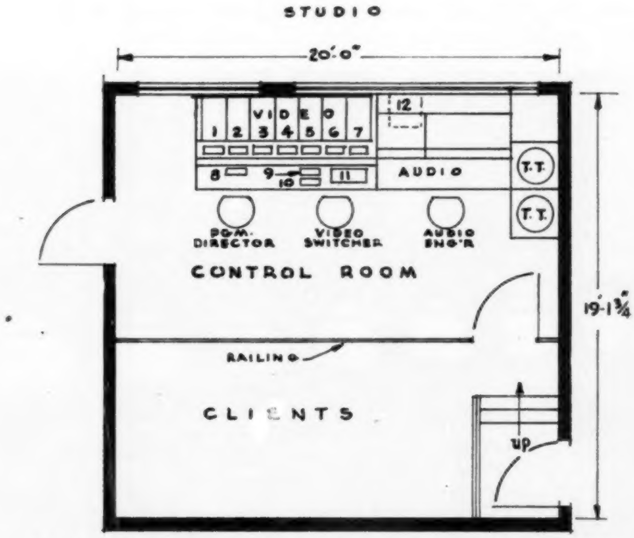

Fig. 2A. Typical floor plan of studio control rooms at 67th Street.

Video Console Components

(1) preview monitor 1	(7) preview monitor 2
(2) camera monitor 1	(8) director's intercom panel
(3) camera monitor 2	(9) projection room remote control
(4) camera monitor 3	(10) technical director's intercom
(5) camera monitor 4	(11) switching panel
(6) line monitor	(12) receiver monitor

used in any combination on any program switched through any of the program control rooms. This flexibility is further increased by the use of a camera cable patch panel in the Camera Control Center, enabling any of the studio camera controls to be patched to cables leading to any of the main studios or announce studios. Thirdly, centralized camera control eliminates the electrical delay problem which arises when several studios are located at different distances from the Master Control Room.

With this new arrangement, it is possible to realize a saving in the number of operating personnel assigned to camera control functions.

The control room space in the 67th Street Studios is divided as shown in Figure 1A. Three studio or program control rooms are provided here, each of which has identical facilities. One of these control rooms is normally used with each of the two large studios. The control room floor level is about two feet above the studio floor. A large window in each control room permits good viewing of the studio.

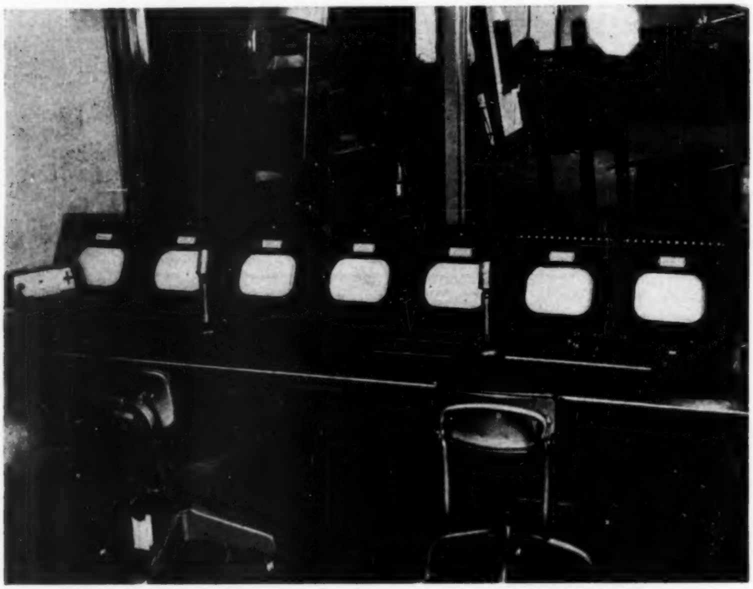

Fig. 2B. Director's console in studio control room.

The third control room, Studio "C" Control Room, is normally used for handling of remote or film programs. Film inserts on remotes are easily handled in this control room by routing the remote signal through the Studio "C" switching system. In addition, all station breaks and film spot announcements are handled in the Studio "C" Control Room. A typical studio control room arrangement is shown in Figs. 2A and 2B. Here the program director's console with its switching control panel is located on the left with the audio control console and turntables on the right. The camera switching is con-

trolled from each director's console by means of a push-button panel containing sixty momentary contact push buttons. These control circuits operate video switching relays located centrally in the Camera Control Center for all studios.

Each of the three studio camera switching systems consists of a relay bank of twelve inputs with five outgoing channels. This permits the handling of up to eight local camera signals and three remote composite signals through any studio control room. In addition, the twelfth input to the switching system is used as an "Effects" input for switching in a super-position, lap dissolve or other type of effect, as required. The five outgoing channels feed the two preview monitors in the director's console, the effects mixer amplifier, and the main program output of that studio.

The space above the program control rooms on the second floor contains the Film Projection Room and the combination Camera Control Center and Master Control Room (Fig. 1B). In the Camera Control Center all of the camera control units are located together in a large U-shaped console, In addition, forty equipment racks house the associated amplifiers, power supplies, synchronizing generators and the power supplies for all the studios.

In the camera control section, eight studio camera controls, each with its picture monitor and oscilloscope and two line monitors form the section facing the studios. A special feature of the Camera Control Center is the camera cable patch panel shown on the right side in Fig. 3. This is mounted on the wall directly adjacent to the camera control units themselves. The sockets mounted on these panels correspond to cables leading to the various studios. The camera cable pigtails that plug into these sockets correspond to the eight studio camera control units. Thus, the eight camera controls can be distributed in any combination among the fifteen circuits to the various studios depending upon program requirements. This adds greatly to the flexibility of the over-all system and makes it possible to take care of almost any special requirement. Furthermore it reduces the total number of camera chains required in such an aggregate of studios.

It is thus that, in case of trouble with the equipment during a program or rehearsal, it is very easy to patch in a spare camera control unit so that the equipment giving trouble may be released for maintenance.

In addition to the patching of the camera control units to any of the studios on the camera cable patch panel, it is, of course, necessary to patch the video outputs of the camera controls on the coaxial jack panels which are mounted in racks adjacent to the program control

room where the switching is done. Also, of course, it is important that tally light circuit information and intercommunication facilities for the particular camera and camera control follow the proper program console. For this purpose a special tally and intercommunication patch panel is provided in the equipment racks directly above the coaxial jack panels. Thus, any camera control can be set up on any of the three camera switching systems for tally and intercommunication control. In this way a camera control operator may plug in a headset to any one of the control sections which he is working and have complete two-way intercommunication with the video switcher down in

Fig. 3. Camera Control Center with camera cable patch panel at right.

the program control room and also with the cameramen. In addition, on a separate earphone he may listen to the program audio from that studio.

The film camera control sections are located adjacent to and on the left of the studio camera control sections, forming part of the over-all console. Switching of these and patching is handled in a manner similar to that of the studio camera controls with the exception that the camera cable from each camera control is tied directly to its corresponding film camera in the projection room.

The film projection room is next door to the Camera Control Center. Here three iconoscope film camera chains are installed, each

with a mirror multiplexer system to combine optically several sources of film or slides on one camera. Two 35-mm film projectors, two 16-mm film projectors, a Gray "Telop" (opaque projector), three 2 × 2 slide projectors and a straight opaque projector comprise the film room projection equipment. Picture monitors for each of the camera chains are located in equipment racks beside the projectors, enabling the projectionist to line up each of his film cameras before being switched on the air. An intercommunication system associated with each film camera enables the projectionist to be in communication with anyone of the three program control rooms to which he is assigned.

Fig. 4. Master control switching console.

In the Camera Control Center is also located the master control switching equipment. The master control switching section is the left wing of the large U-shaped console (Fig. 4). This equipment is all relay-operated and comprises a switching system for handling six studios to four outgoing channels. It is a preset switching system for both audio and video and is arranged for either simultaneous or independent audio-video switching as required. Provision is made for either tripping all four outgoing channels with a single master switch or any group of them together. A picture monitor and oscilloscope

as well as an audio monitor and audio level meter are assigned to each outgoing channel so that levels on each outgoing channel can be set independently as well as monitored.

Two synchronizing signal generators are provided, one for standby use in case of trouble. An RCA Genlock unit has also been installed which permits the line-by-line as well as field-by-field phasing of the local synchronizing signal generator with an incoming remote signal. This permits the use of a remote signal in lap dissolving and superposition with local cameras and it has been found to be particularly effective with film commercials inserted during remote programs.

The new WOR-TV Studios have been in use since about the first of February. During this time it has been found that the facilities have met almost all of the requirements put upon them by the Program Department. Flexibility in meeting these requirements has been apparent in producing programs that would have been very difficult under more usual conditions. In addition, centralized camera control operation has resulted in helpful economies in both manpower and maintenance.

Infrared Photography With Electric-Flash

By FREDERICK E. BARSTOW

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SUMMARY: Electric-flash sources produce infrared as well as visible and ultraviolet light. Using only the infrared portion, the guide number for infrared film is equal to or higher than the guide number for Kodachrome using the visible portion from the same source. Factors affecting the infrared output are discussed. Described is a small airplane instrument panel photographic recorder using an infrared filter over the flashtube to avoid distraction of the pilot. The short-duration infrared flash gives very readable records on 16-mm film at one-second intervals.

The existence of the infrared portion of the spectrum has been known since the early part of the last century, and infrared photographic records have been produced for over sixty years. However, it was not until 1931, when advances in sensitive materials were made, that the application of infrared photography became practical.[1] Photography using wavelengths longer than 13,000 A (Angstrom units) is still difficult. Present-day applications depend on: (1) the ability of infrared radiation to penetrate haze; (2) differential absorption and reflectance of these long wavelengths by different materials; and (3) the inability of the human eye to respond to infrared light. These properties have led to the use of infrared in aerial photography, camouflage detection, crime detection, medicine, botany, and many other fields.

For some subjects the source of infrared radiation is the subject itself, but in all other cases some external source must be used. Common infrared sources are sunlight, incandescent light, arc lights and photoflash lamps. Less common, although not new, is the use of electric-flash (stroboscopic or high-speed lights) which makes possible the practice of infrared photography using very short exposures. It is this type of infrared light source and its application with which this paper is concerned.

Twelve or fifteen years ago electric-flash techniques were little known, but today their use is commonplace.[2] Several papers on this subject have been published in this Journal.[3,4] However, it is less generally known that an electric-flash source emits a great deal of infrared radiation. Figure 1, a typical spectral distribution curve of

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a commercial electric-flash tube, shows that the energy reaches a maximum in the blue, decreases to a minimum in the near-infrared, and then increases again. The energy per 100-A band in the infrared is approximately half the energy per 100-A band in the visible. The total energy in the visible region of 4,000 to 7,000 A is only about three times the total energy in the infrared between 7,200 and 8,700 A, but this figure will vary considerably between tube types and with other circuit constants. Thus it is seen that electric-flash is an effective source of infrared light.

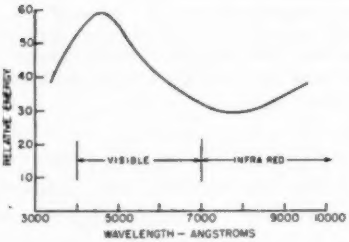

Fig. 1. Spectral energy distribution for a typical flashtube; data supplied by General Electric Co.

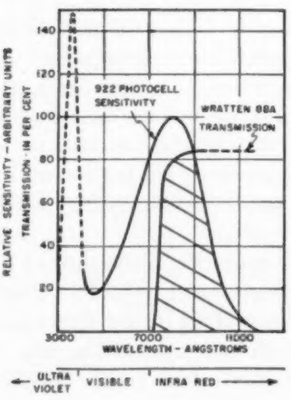

Fig. 2. Characteristics of the red-sensitive photocell and Wratten 88A filter used for measuring infrared radiation. The shaded region represents the response of the combination.

INFRARED EFFICIENCIES

The spectral energy distribution of Fig. 1 is for a standard commercially available electric-flash tube used for normal black-and-white or color photography. The question immediately arises as to the possibility of changing the tube design or operating conditions to increase the infrared output. Factors which should be investigated are voltage, capacity, tube loading, tube dimensions, gas pressure

and types of gases. To obtain some indication of the effect of voltage and capacity on infrared output, three types of tubes were investigated. Infrared light measurements were made with a special integrating-type light-meter[5] designed for use with electric-flash, which employed a red-sensitive photocell and a Wratten 88A infrared filter.[6] Figure 2 shows the sensitivity curve of the photocell and the transmission curve of the 88A filter. This filter has a transmission of less than 0.1% below 7,200 A. The overlapping of the two curves (shown by the shaded area) represents the region of response of this combination of filter and photocell. This region extends from 7,200 to 12,000 A.

Using the methods of measurement described, three different types of flashtubes were investigated to determine the effect of voltage and, to a limited extent, energy loading on the infrared output. The General Electric Co. FT–110 is a new flashtube designed for 1,000-v operation in portable electric-flash equipment. Its infrared effi-

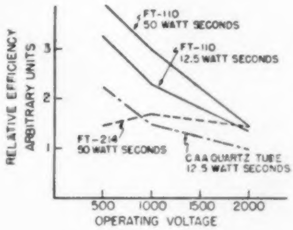

Fig. 3. Effect of operating voltage on the infrared efficiency of several flashtubes.

ciency, as shown in Fig. 3, is nearly three times as high at 500 as at 2,000 v when operated at 50 w-sec (watt-seconds), and approximately twice as high when operated at 12.5 w-sec. The CAA (Civil Aeronautics Administration) flashtube shows an infrared efficiency more than twice as high at 500 as at 2,000 v. This tube is a very small quartz lamp designed specifically for an infrared instrument recorder described later in this paper. The GE FT–214 is a standard 2,000-v flashtube used for portable and semiportable flash equipment. Its infrared efficiency remains approximately constant over this voltage range. From these limited data, it is probably safe to state that for maximum infrared efficiency a flashtube should be designed for as low voltage as is consistent with proper starting characteristics and flash duration.

The other design factors of tube dimensions, gas pressure and type of gas also may very well affect the infrared efficiency and should be investigated as they have been for the visible region.[2]

GUIDE NUMBER

Although the energy in the infrared approaches the energy in the visible region of an electric-flash source, the lower sensitivity of infrared film makes the over-all combination of electric-flash source, filter and infrared film considerably slower than the electric-flash panchromatic film combination. However, it is as fast as, or slightly faster than, the electric-flash Kodachrome combination. These speeds can be considered in terms of the commonly used guide num-

Fig. 4. Electric-flash infrared photograph; note "freezing" of fan blade.

bers (aperture or *f*-stop multiplied by distance). For example, a small electric-flash unit might have a guide number of 150 to 200 for super-speed panchromatic film, a guide number of 30 for Kodachrome, and a guide number of 30 to 50 for infrared film when a Wratten 88A filter is used. It is understood that if a Wratten 87 filter, which cuts off at approximately 7,600 A, is used, the guide number will be reduced. It can be said in general that the infrared guide number will be at least equal to the Kodachrome guide number for a given electric-flash unit. Any subject that can be photographed in color can probably be photographed in infrared with identical equipment.

A commercial 10,000-w-sec flash unit having a guide number for Kodachrome of 250 could be used to photograph in infrared an area of several thousand square feet at an aperture of $f/3.5$. A press photographer's portable strobe unit could be used for figure length photographs at perhaps $f/2.5$, and finally, working toward smaller and smaller areas, infrared photomicrographs with electric-flash should be well within the realm of possibility. Figure 4 is an infrared photograph taken with a flash unit using a guide number nearly 50% higher than the guide number which normally would be used for Kodachrome.

A Data Recorder Using Electric-Flash Infrared Light

Development

An ideal application of electric-flash as a source of infrared light is represented in a small automatic data recorder or "cockpit observer" for photographically recording instrument readings in aircraft during flight tests. The development of an instrument for use on extended flights was sponsored by the Civil Aeronautics Administration and participated in by the Fairchild Camera Co. through a contract with the CAA in 1936. It was extended through a contract with Eastman Kodak in 1941. The intention was to filter out all visible light and photograph with infrared in order to remove all possibilities of distracting the pilots. Incandescent sources were originally used, but the relatively long exposures required resulted in blurred images due to aircraft vibration. Electric-flash as the infrared light source offered the possibility of eliminating this defect.

A CAA Contract with Edgerton, Germeshausen & Grier, Inc., in 1943 resulted in two special 16-mm cameras and an experimental 110-v a-c electric-flash unit. The cameras constructed by the Eastman Kodak Co. were adaptions of the standard 16-mm Magazine Cine Kodak. The spring motors were removed and electric motor-drives substituted. Fast-acting overriding shutters were incorporated to give a short exposure despite the slow operating speed of two frames per second. This was necessary to minimize the effect of daylight which would have superimposed an additional exposure of long duration. Contact synchronizers with zero time delay were also incorporated for synchronizing the electric-flash. The cameras proved to be very satisfactory for this application.

In 1947 the application requirements of the equipment were changed to those of a flight test recorder, in particular, for small aircraft. Inasmuch as the principal requirement was to have a source of

illumination essentially invisible to the pilot, C. W. Wyckoff of the Edgerton, Germeshausen & Grier staff undertook to re-evaluate the relative merits of working in the ultraviolet or infrared regions of the spectrum. It was determined that although the over-all efficiency in the ultraviolet region was considerably greater than that in the infrared, it would have been necessary for the pilot to wear light yellow glasses to cut out the blue portion of the spectrum. In addition to this disadvantage, the contrast using ultraviolet light was considerably less than that obtained with infrared light. Further, the ultraviolet light would cause the luminescent dial paints to glow,

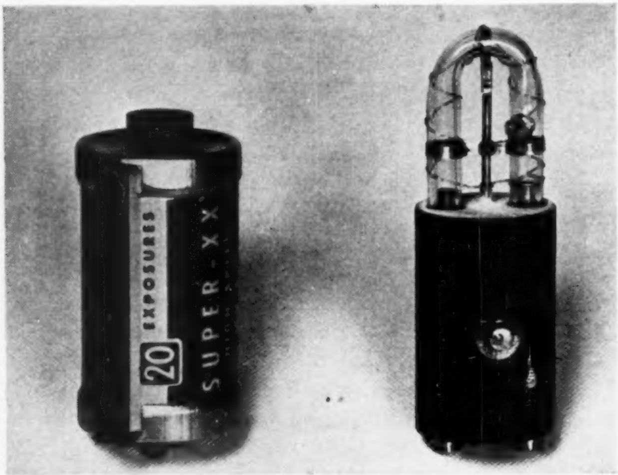

Fig. 5. Quartz flashtube for infrared recorder compared in size to a 35-mm film cartridge.

which might or might not have been a disadvantage. Having concluded that an infrared source had the greater advantage, the CAA outlined certain requirements for the recorder: (1) area to be covered, 11 × 14 in.; (2) camera to instrument panel distance, 36 in.; (3) maximum aperture, $f/1.9$; (4) picture rate, one per second; (5) power source, 12-v battery; and (6) minimum size and weight.

A few simple photographic tests with standard flashtubes indicated that a special flashtube would be desirable. Two seemingly incompatible factors enter into the design of a flashtube which is to be operated at high repetitive rates. If it is small, it will overheat due to the average power input, but will have high efficiency. If it is

increased in size to handle the average power, it will have low efficiency, requiring in turn a higher average power input. When these conditions apply, it is advantageous to construct the tube of quartz which can be operated at a much higher temperature level than glass, and a compromise must be made between efficiency and power handling ability. For the CAA recorder, a small quartz U-shaped tube (see Fig. 5) was designed which had a reasonable efficiency and was able to handle the necessary power without overheating. Its size permitted the use of a very small reflector without sacrificing reflector efficiency. As shown in Fig. 3, its infrared efficiency is about 50% higher at 500 than at 1,000 v and hence a voltage operating level of 475 to 500 v was chosen. This voltage level has the advantage of simplifying the power supply design for an airborne application. The dimensions of the tube and gas pressure are such as to give reliable starting at this voltage. A special mounting base protects the fragile graded quartz-to-tungsten seals and fits into a standard

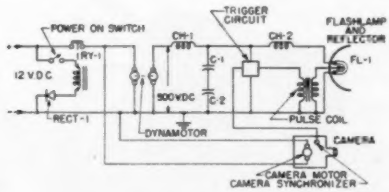

Fig. 6. Schematic diagram of infrared electric-flash instrument recorder.

fluorescent starter socket which locks the flashtube in place, but at the same time makes it easily removable. Adequate spacing for the spark lead is obtained by placing its termination well up on the side of the base. Using a Wratten 88A filter over a small reflector, 4 in. in diameter, a Wratten 88 filter over the lens, and infrared film, an input to the flashtube of 12 to 14 w-sec gives the illumination required for the recorder.

Circuit

The circuit (Fig. 6) has several features of particular interest. Inasmuch as the primary power source was to be an aircraft 12-v battery, one of three types of conversion was available: (1) vibrator, transformer and rectifiers; (2) d-c to a-c inverter, transformer and rectifiers; or (3) 12-v d-c to 450-v d-c dynamotor. Dynamotors are generally preferred to vibrators in aircraft and eliminate the need for transformers and rectifiers and therefore were chosen as the means

of voltage conversion. This would not have been practicable if the voltage requirement had been much above 500 v.

Two 220-μf 475-v electrolytic capacitors (C–1 and C–2) are conservatively operated in series to give an energy storage of about 12 w-sec. Chokes CH–1 and CH–2 both serve to prevent "hold-over" in the flashtube FL–1. A "hold-over" in a flashtube is a continuous glow which occurs if an attempt is made to recharge the capacitors too rapidly. The tube is in a highly ionized state after being flashed

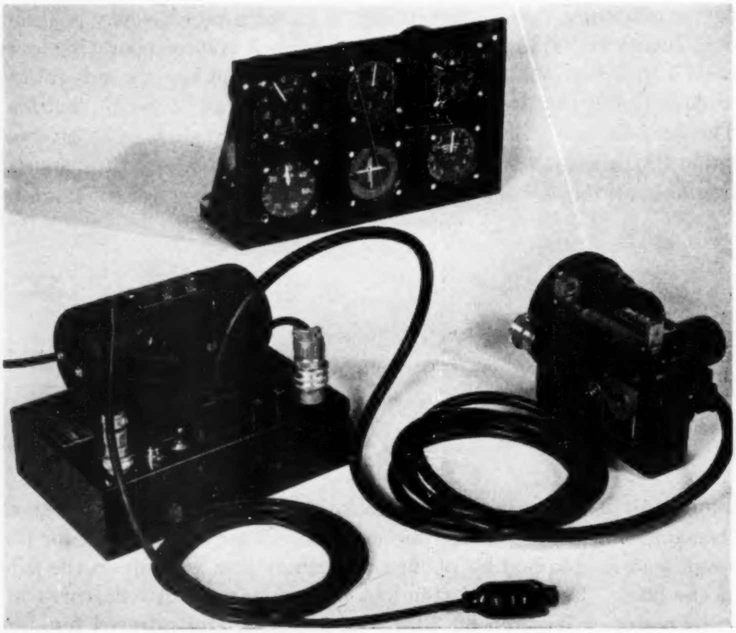

Fig. 7. Complete infrared electric-flash instrument recorder, showing power unit, camera and lamphouse assembly, cables and a mock-up of instruments.

and, if sufficient current is supplied, the tube will not deionize but will remain conducting and act as a short circuit across the power supply. A choke (CH–1) acts as a high impedance immediately after flashing to limit the current and thus prevent "hold-over." On the other hand, over a period of one second it acts as a relatively low impedance and therefore allows the capacitors C–1 and C–2 to charge fully before the next flash. An additional choke (CH–2) in series with the flashtube also tends to prevent "hold-over" by causing a

slight reversal of voltage, thereby allowing the tube to deionize. The amount of reversal must be limited to a small value to prevent damage to the electrolytic discharge capacitors.

To prevent inverse output voltage from the dynamotor, which in turn would cause failure of the electrolytic capacitors, it is necessary to prevent operation of the dynamotor in the event that the polarity of the battery voltage is ever reversed. This is accomplished by placing a selenium rectifier in series with the coil of the main control relay RY–1 which prevents its closing if the polarity of the voltage is incorrect.

The cameras described previously have had new 12-v d-c governor-controlled motor-drives installed to operate them at one frame per second to within an accuracy of about 1%. The nonreversal protection described above also prevents the camera motors from driving the film in the wrong direction.

Mechanical Design

Figure 7 shows the complete unit (total weight 18 lb), which includes the power supply, camera, lamphouse assembly and cables. A test bank of instruments is also shown. The motor-drive, governor, and lamphouse are attached to the camera, but the lamphouse may be removed for side-lighting by releasing two small snaplocks. Slack cable coiled inside the motor-drive housing allows operation of the lamp up to 30 in. from the camera. The total weight of the camera unit (including camera, motor-drive, and lamphouse assembly) is approximately 4 lb. The camera and lamphouse are shown in Fig. 8 which illustrates how a Wratten 88A filter is held in place over the reflector by a grooved rubber ring that also serves to prevent any unfiltered light leaking around the edge of the filter. It will be noted that the camera also has an infrared filter (a Wratten 88) and that the flashtube is located so that the legs of the U are in a horizontal plane. This orientation tends to spread the light in the horizontal direction corresponding to the longer axis of the 16-mm frame. The power supply is a rectangular aluminum box with all components attached to the cover for easy servicing. The dynamotor is placed on top for maximum cooling.

In the laboratory the unit has operated very satisfactorily. Figure 9 is an infrared photograph of a test instrument bank taken with the recorder at 36 in., an angle of 30 deg, and an aperture of $f/1.9$. As data can be taken readily from exposures made at $f/2.8$, it should be possible to photograph areas slightly larger than specified, and by the use of two recorders, more extensive instrument panels can be

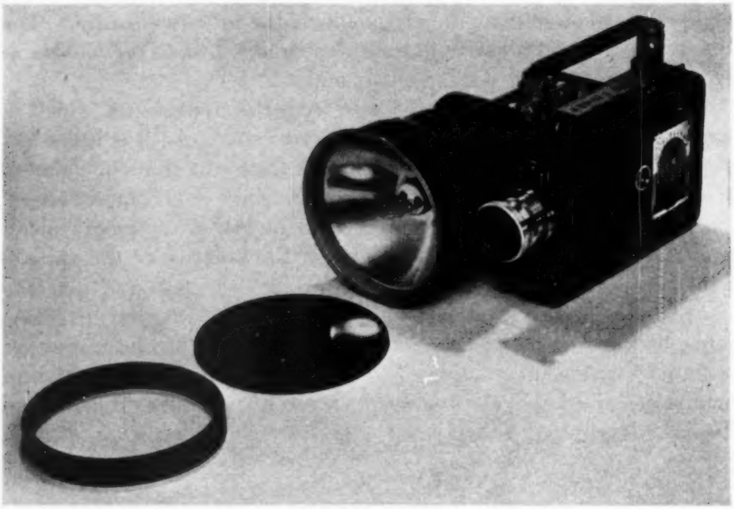

Fig. 8. Camera and lamphouse assembly showing infrared filter and rubber retaining ring removed.

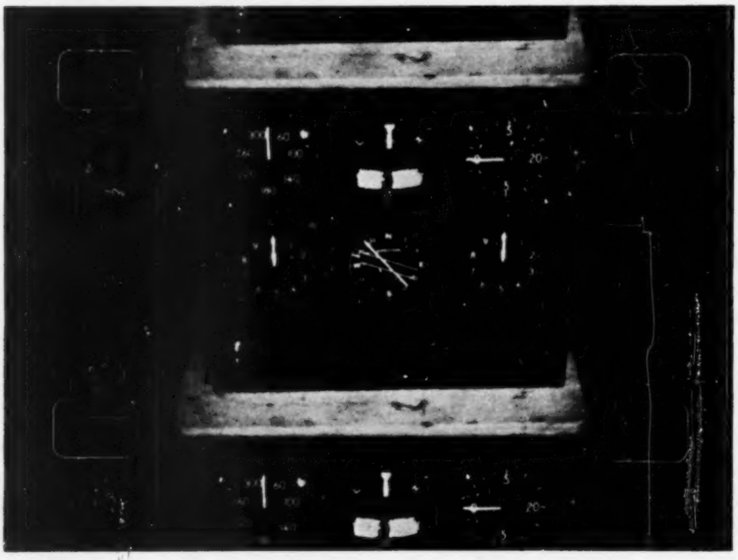

Fig. 9. Enlargement of section of 16-mm film made with the CAA infrared electric-flash instrument recorder.

observed. At the operating rate of one per second a series of over 2,000 photographs covering a flight test of over 30 min is possible without reloading.

In contrast to special recording systems which require a separate bank of test instruments, this device can be readily installed in the cockpit of even the smallest aircraft to record data from the standard instrument panel. However, without the infrared filters it is also adaptable for use in recording much larger aircraft instrument installations located where the flashing light would not distract the pilot. Installation and testing of this infrared recorder in a DC-3 airplane is now being carried on by the CAA.

CONCLUSIONS

Commercial electric-flash techniques can be used to provide infrared light for infrared photography. Guide numbers at least as large as those for Kodachrome can easily be obtained. The efficiency of electric-flash as an infrared source is generally highest for a tube designed to operate at the lowest practicable voltage. An aircraft instrument recorder, or "cockpit observer," employing electric-flash as an infrared source has been designed and shows satisfactory performance in laboratory tests.

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Magnetic Sound Film Developments in Great Britain

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SUMMARY: The introduction of magnetic sound film recording and reproducing apparatus into Great Britain is described as well as the types and characteristics of magnetic film available. Details and the general circuit arrangement of the apparatus are given together with a description of special apparatus which has been used for adding a visible signal indication record to the invisible magnetic sound track. Apparatus which has been evolved for the bulk wiping of magnetic film stock is also described as well as experience gained with different types of magnetic film joints.

Most people are familiar with the Telegrafone, the name which Poulsen gave to his magnetic sound recorder and reproducer, in which a steel wire was run past a magnetic head to which signals were fed and thereby recorded on the wire, the signals being subsequently picked up again from the steel wire by means of the same or a similar magnetic head.

The steel wire recording system developed very slowly, mostly due to the absence of any large developments in the electronic field, but when, after World War I, thermionic valve amplifiers, good microphones and good loudspeakers were developed, the steel wire was again taken up but only for speech and signal (e.g., Morse) recording. It did not find its way into the motion picture industry chiefly for two reasons:

Firstly, the quality was not very good and could not compare with that of photographic sound.

Secondly, the speed of the steel wire was much too fast to allow it to be synchronized satisfactorily with the picture.

The Magnetophone: Successor to the Telegrafone

Some years before World War II, Pfleumer in Germany had developed the use of magnetic iron oxide powders on tapes as a magnetic sound recording medium and the Allgemeine Elektricitäts Gesellschaft had marketed a machine for the use of it; but even this new apparatus, called the Magnetophone[1] did not open the field of application to the motion picture industry, since the quality was still of the standard of a dictating machine.

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High-Frequency Bias for Magnetophone Tape

However, further developments during World War II, especially in Germany by Braunmühl and Weber,[2] who applied the high-frequency-bias method of recording to the oxide tape, changed the situation materially, as they produced a magnetic sound record greatly improved and far superior to the old d-c[3] or even a-c[4] biased Telegrafone and the Magnetophone, d-c operated until that time. It was now possible to obtain a quality comparable and even superior to any other recording means with a frequency response up to 20,000 cycles/sec and with the tape running at the reasonable speed of about 30 in./sec.

Application to the Motion Picture Industry

The motion picture industry now started to take an interest in these new developments in magnetic recording and the possibilities of introducing magnetic sound into the industry were examined in different countries.

In Great Britain immediately after World War II an examination of the advantages of the application of magnetic sound to the film industry was made. Investigations at that time revealed that a very high quality could be obtained from magnetic sound record carriers at a considerably reduced speed. At the speed of standard 35-mm film a frequency range up to 10,000 cycles/sec was obtained while at 16-mm speed up to 7,000 cycles/sec was obtainable and even at 8-mm speed up to 3,500 cycles/sec could be reproduced.

In addition to the excellent frequency response a very good signal-to-noise ratio was obtained, being at least 10 db better than the best photographic sound film recorded with a ground noise reduction system.

Nevertheless, a lot of development work had to be undertaken subsequently to enable the new type of sound recording to be introduced into the studios. This work consisted mainly of two parts: firstly, the manufacture of perforated film base with the new magnetic coating; and, secondly, the provision or adaptation of apparatus for the recording and reproduction of the new type of sound record carrier.

Magnetic Film Stock

Figure 1 shows three different types of magnetic film coatings (A, B and C) which have been evolved for use in the motion picture industry. In type A (Fig. 1) the coating is applied over the entire width of the film. For this purpose large sheets of a suitable non-

inflammable base are coated and afterwards slit and perforated. Large quantities of the base material can be coated quickly in this way but the slitting and perforating of the coated material quickly blunts the tools used for these operations due to the abrasive action of the iron oxide coating and resharpening of the knives and punches is necessary after a relatively small number of reels have been made.

Type B (Fig. 1) illustrates a kind of magnetic film with which this drawback has been overcome by slitting and perforating the base material before applying the coating. In this case the coating is applied only to the surface between the two rows of perforation holes. This has the further advantage that it enables the usual footage and edge numbers to be retained along the entire length of the reel.

Type C (Fig. 1) is a third kind of magnetic film where the magnetic coating extends over only approximately half the width of the film space between the perforation holes, the other half being provided

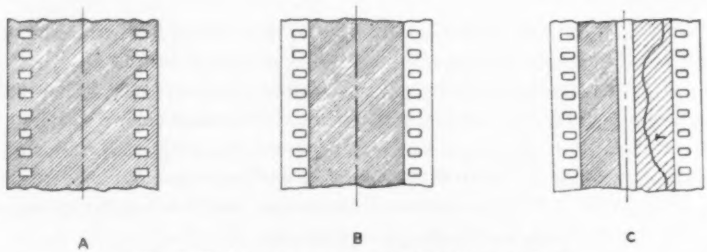

Fig. 1. Different types of magnetic film coatings.

with a layer of a white or light-colored material upon which notes, cue signs and other visible indications can be made, for example, for synchronization purposes.

Optimum Bias and Frequency Response

Magnetic sound film stock eventually became available from several sources in appreciable quantities and comparisons and measurements were made of the different manufacturers' products in order to use them in the most suitable way. It was found that the various coatings differed considerably and usually required a change in the amount of the supersonic bias in order that the best results could be obtained from each different coating.

Figure 2 illustrates graphically the output level of three different kinds of magnetic film stock plotted versus the bias current.

Curve A refers to a medium-hard coating from which the maximum

output is obtained with a bias current of approximately 80 ma (milliamperes).

Curve B refers to a soft British film; it gives its optimum output when the bias current is about 45 ma.

Curve C represents the behavior of a sample of Continental stock which requires a bias current of about 70 ma in order to obtain its maximum output.

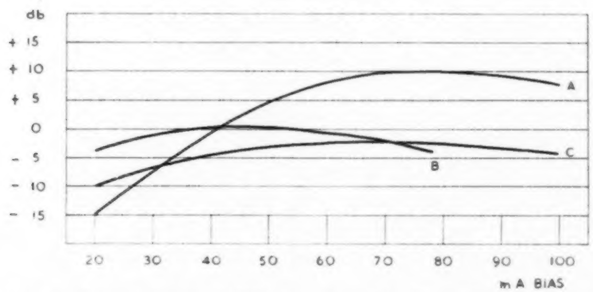

Fig. 2. Output level of different magnetic films plotted versus bias current
(A, American; B, British; and C, Continental film stock).

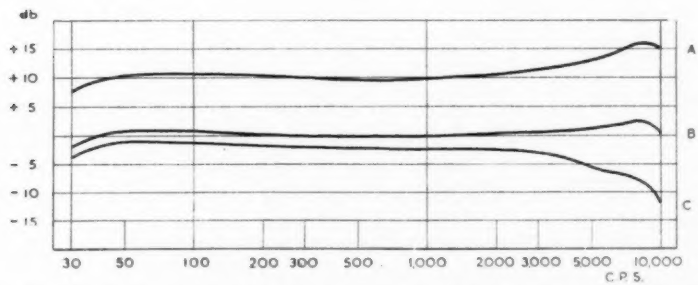

Fig. 3. Frequency response of different magnetic films at optimum bias current for each film (A, American; B, British; and C, Continental film stock).

Investigations also showed that different types of magnetic film stock exhibited different sensitivity and frequency responses. Figure 3 gives an example of three different types of stock in which the curves shown illustrate measurements made with the bias current adjusted to give the maximum output from each different make of film. The recording and playback equipment was adjusted in such a way as to give an almost flat response for the British film (curve B); with the same adjustment a medium-hard American film (curve A) gave 10 db

more output and, in addition, an increased top response. Curve C refers to a Continental sample of magnetic film from which it will be seen that the output signal strength is down 2 db compared with the British film while a poorer top response is also exhibited.

Compensation for the differences in output and top response can, of course, be made in the playback amplifier but at the cost of increased background noise in the case where considerable boosting in the higher audio range is required.

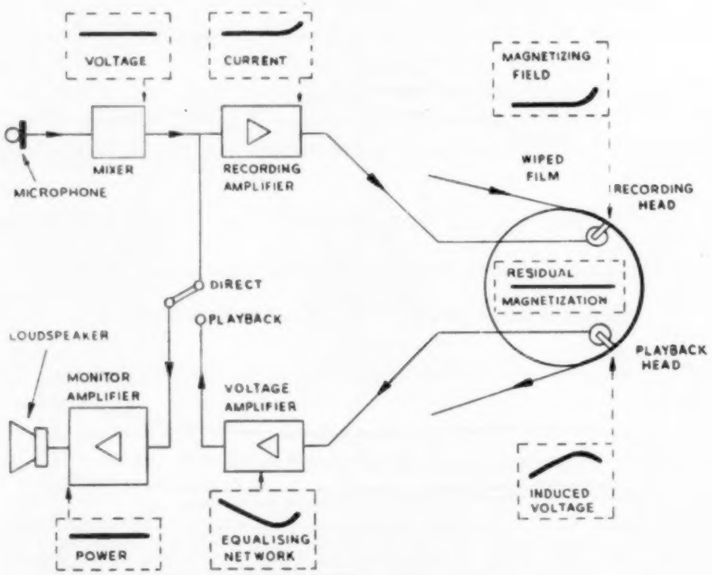

Fig. 4. Block diagram of magnetic sound film system.

General Circuit Arrangement

Once the required magnetic film stock had been obtained and its characteristics and response curve ascertained the next step was to provide the necessary apparatus for actually recording and reproducing sound magnetically. As the same or even better results must be expected from the new magnetic system as from the well-established photographic sound channels, it was an obvious step to adapt existing photographic sound apparatus to the new system, the main difference being that the optics and provision for optical adjustments are eliminated and replaced by a magnetic head consisting of a coil having an annular core of soft magnetic material with a well-defined gap.

In Fig. 4 the general layout of a magnetic sound-on-film system is schematically illustrated. The signal current created by the sound impinging upon the recording microphone is passed on to a voltage amplifier and mixer having a straight line response. From there it is fed to a recording amplifier with a pre-emphasizing characteristic compensating for losses, particularly of the higher frequencies, incurred in the transfer of the signals from the magnetic recording head to the magnetic sound film. The curve shown above the recording amplifier block illustrates schematically the pre-emphasis to which the signal current is subjected prior to the actual recording step so that the signals recorded on the sound carrier then have an almost straight line frequency characteristic.

The sound record carrier, with its magnetic layer now magnetized, passes round the recording drum to a second magnetic head (playback head) which can be used either for reproducing or for monitoring while recording takes place. As the frequency characteristic of the signals picked up from the film is not straight it has to be equalized by the inverted characteristic of a special equalizing network and voltage amplifier the output of which is passed to a power amplifier feeding the reproducing loudspeaker.

In order to adjust the equipment and, also, for purposes of comparison during recording, a change-over switch is provided by means of which the signals from the microphone amplifier can be fed either directly to the monitor power amplifier and the loudspeaker or, alternatively, via the recording amplifier and head, record carrier, reproducing head and amplifier to the same power amplifier and loudspeaker. If the apparatus is properly adjusted there will be no audible difference between the sound from the loudspeaker reproduced directly and that played back through the magnetic recording and reproducing channel.

Recording and Reproducing Equipment for Magnetic Film

Figure 5 illustrates the general assembly of an equipment which has been adapted from photographic sound film apparatus and can be used not only for the magnetic recording of sound but also for reproducing it in synchronism with a complementary picture film. It consists of a combined recording and reproducing machine driven by a synchronous or an interlock motor and an assembly of amplifiers and ancillary units. The equipment can be connected to any microphone input or mixer table (not shown in the photograph). A special wiping head for erasing any signals remaining on the film from a previous recording is provided in the path of the film before reaching

the recording point thus allowing previously recorded films to be re-used.

Figure 6 is a view of a photographic sound camera which has been adapted for recording sound on magnetic film. A feature of particular interest in this camera is the manner in which the recording and play-back heads have been mounted.

Long experience in recording and reproducing sound films has shown that it is most advantageous to record on and reproduce from the film when the latter passes round a drum connected to a shaft

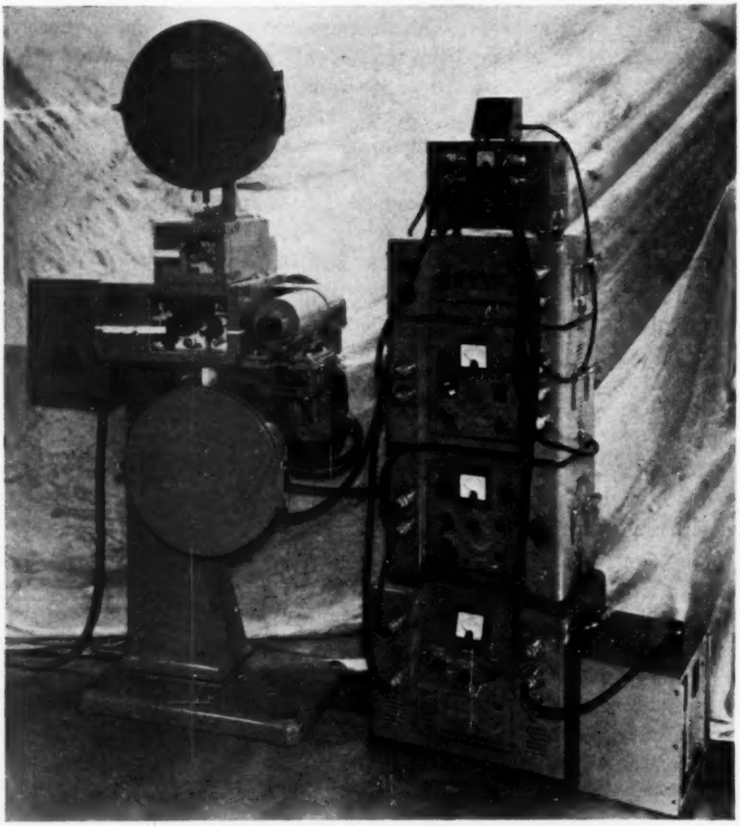

Fig. 5. General assembly of magnetic sound film recording and reproducing equipment and amplifier stack.

carrying a flywheel because inertia is added to the film which, itself, is virtually without mass.

This procedure has been followed in the camera illustrated by Fig. 6 with the additional arrangement that the flywheel drum has been constructed with an annular recess within which the magnetic heads are accommodated. The arrangement is such that the magnetic layer faces the drum while the film is supported on the outer parts only, the middle portion of the film, that is, the part covering the recess, being without any other support except for that of the curved surface of the magnetic heads which are located inside the cylindrically shaped portion of the film passing round the drum.

In cross section the flywheel drum is H-shaped, the horizontal bar of the H coinciding with the drum axis, the space above and below the axis being occupied by the heads which are supported on rigid arms placed in such a way as not to interfere with the passage of the film through the apparatus. The ends of the arms remote from the

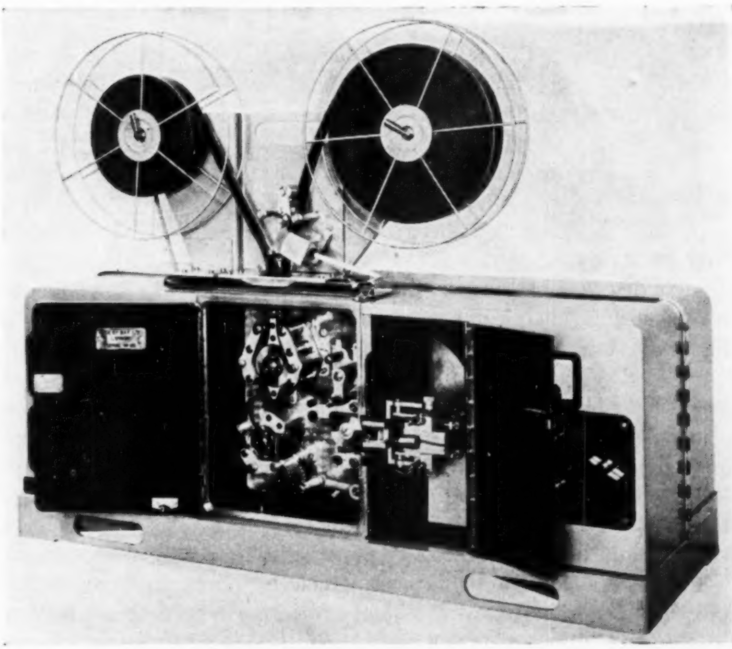

Fig. 6. Magnetic sound film camera with the magnetic heads mounted inside the recording drum.

heads are connected to a mechanical assembly by means of which all movements necessary for adjustment are carried out.

Synchronization

Contrary to a photographic sound record, it is impossible on a magnetic record to ascertain whether or not sound has been recorded on the film merely by looking at it and should sound have been recorded it is impossible to see where the recorded signals begin or end.

The simplest way of obtaining an approximate idea of the beginning and end of sound passages on the film for the purposes of synchronization, editing and cutting is to rely upon an audible signal reproduced from the film. This was easily arranged on the existing photographic sound-editing machines by removing the optical system and exciter lamp and replacing these parts with a magnetic pickup head.

In certain cases it is more advantageous to provide the editor with a visible indication of the actual sound signals. This visible indication could be a registration of similar indication of the actual signals or a registration of their envelope or an indication derived from them.

In Fig. 1–C the envelope of the invisible magnetic sound signals contained in the left side of the sound record is indicated by the trace T on the right side. This visible registration of the sound signals can be effected in several ways, for example:

(a) by an inking method in which a small nib fed with indelible ink traces the envelope of the sound waves;

(b) by a stylus which engraves the visible indication on the white coating; or by

(c) a dry chemical process in which a stylus made of a special metal reacts with a chemical compound in the white coating shown in Fig. 1–C.

Method (c) has given the best and quickest results and has been used on film stock of the kind shown in Fig. 1–C in which the white coating consists of zinc oxide mixed with a nitrocellulose lacquer and coated on the film. The recording stylus is made of bronze or brass or a similar alloy and the reaction between the metal stylus and the coating forms the trace T. This latter process has the advantage that it is entirely dry and can be carried out at almost any speed.[5]

Figure 7 illustrates apparatus which has been evolved for the purpose of adding a visible signal indication record to a magnetic sound film; this consists of a magnetic pickup head of the ring-shaped kind (recognizable in the photograph by the circular side plate held in position by screws) which is arranged in contact with the magnetic

coating on the film on which sound has already been recorded. This head picks up the recorded signals and the induced currents are fed to an amplifier, rectified, and applied to an electro-mechanical device located adjacent to the magnetic head. This device carries a stylus, in a somewhat similar manner to a gramophone needle, at the end of the arm shown protruding from the casing. The device is energized when the rectified signal currents are fed to it and the stylus, which is of the metallic alloy kind described above, traces a visible signal indication of the type shown in Fig. 1–C corresponding to the adjacent magnetically recorded sound signals. From this trace it will be seen that periods of silence are indicated by a straight, unmodulated line while sound passages are indicated by modulation of the

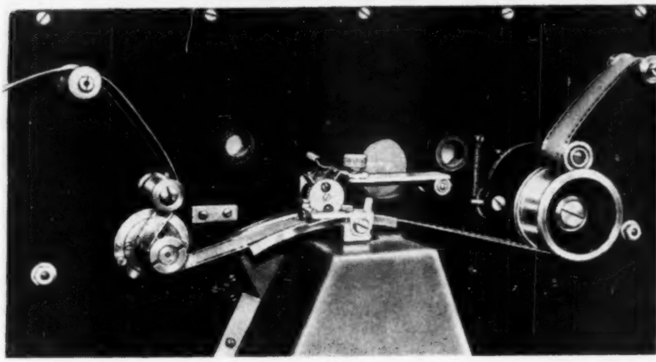

Fig. 7. Apparatus for adding a visible signal indication record to the magnetic sound film.

line. By these means the beginning and end of words and sound passages can be easily and accurately located whereby the editing and precise cutting of the magnetic sound record is greatly facilitated.

Joints

During the editing and cutting of the magnetic sound films a certain amount of trouble was experienced at first when making the joints as it was found that steel scissors and film splicers having steel plates and cutters often tended to magnetize any such joints made with them.

Magnetization caused in this way is only partly removed by running the film over the usual erasing head as the latter loses contact near and on the joint and therefore effects only a partial erasure.

Two ways have been evolved for overcoming this difficulty.

When it is only a question of joining a number of scenes and editing the different takes, the quickest method has been found to be to join the individual lengths of film together in the usual way and to punch a hole (either round or preferably diamond-shaped) through the position of the joint on the sound track as shown in Fig. 8–A. The cutting, splicing and punching tools for carrying out this operation should be nonmagnetic and preferably made of nonferrous material; in this respect tools made of beryllium copper have so far proved to be the most satisfactory.

However, should the cutting and punching be done with steel tools it has been found that demagnetization of the joint with an erasing tool helps to make it silent.

This erasing tool or, as it is better known, "magnetic brush," consists of an iron bar surrounded by a coil which is connected to the ordinary mains current supply. The tool which, in effect, constitutes a low-frequency magnetic field, is provided with a handle and this gives it the appearance and ease of handling of a soldering iron.

This instrument has proved very satisfactory in all cases where small amounts of remanent magnetism have had to be removed from

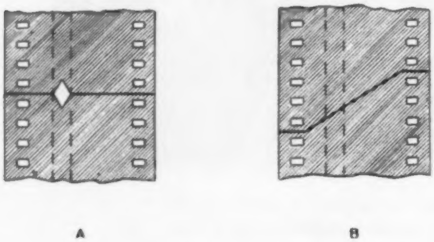

Fig. 8. Magnetic sound film joints (A, for joining separate takes; and B, for joining lengths of stock wiped for re-use).

film joints or other small articles by simply touching or gently brushing it over the item to be demagnetized.

The second method of eliminating remanent magnetism from film joints has been found to be of most value in cases where lengths of wiped stock (film stock from which a previous recording has been erased) are joined together and again made available for recording. In this case it has been found best to remove all existing joints, including those punched through in the manner described above, and to make fresh oblique joints of the kind shown in Fig. 8–B. This type of joint has proved to be very satisfactory in practice as well as being silent and it is even possible to record sound signals over such a joint, after demagnetization, without any noticeable effect when the sound is reproduced.

Bulk Wiping

The magnetic film stock is generally kept for the sake of convenience in the form of reels or spools and the erasing or wiping is usually effected by unwinding the film, drawing it past a magnetic erasing head, and then rewinding it on to a further spool.

However, as large reels up to a length of one thousand feet or more are usually employed in practice, it will be appreciated that a considerable time is needed to carry out the erasing operation while there is always the danger of insufficient demagnetization at the joints due to loss of contact with the erasing head and the necessity of paying particular attention to the demagnetization of them.

It would therefore be highly advantageous if the recorded signals on a whole reel could be erased in a single operation without the

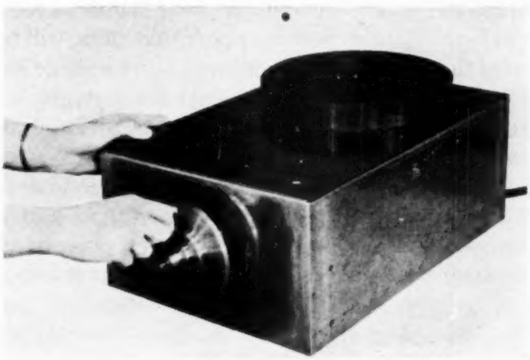

Fig. 9. Laboratory model of apparatus for wiping magnetic film in bulk.

necessity of the reel being rewound, that is, so that the magnetic signals are erased while the film itself is maintained in a reeled, i.e., bulk form.

Such means for the bulk wiping of magnetic sound records have been devised and consist of a turntable upon which the reel is rotated in mutual combination with the translatory movement of an electromagnet which produces an erasing field.

Figure 9 illustrates the original laboratory model of the apparatus which has been evolved. The film is placed on the turntable which is then rotated by means of the handle through internal gearing. A lead screw forming part of the drive mechanism also drives an electromagnet toward and then, upon reversal of the direction of rotation

of the handle, away from the rotating reel of film so that this is evenly and uniformly demagnetized throughout, including all the joints in it.

Conclusion

The use of magnetic sound in the motion picture studios has only really just begun and the evolution of a new technique to handle it to its best advantage has not yet been fully completed.

While there are many instances where photographic stock cannot be used for practices for which magnetic stock can now be employed it is difficult to visualize any developments which will bring magnetic sound actually into the cinemas because of the commercial as well as technical difficulties of replacing photographic sound there.

The answer to the question which is often asked as to whether magnetic recording will ever completely replace photographic recording seems to be: No. Rather, does it appear that there will be a happy combination of the two kinds of recording: the magnetic recording in the studios up to the time when the final photographic negative is prepared from which the release prints are made, and the photographic system, as now, in the cinemas themselves.

Nevertheless, there may be applications of magnetic sound, tentative as yet, in which it will play an ever increasing part as, for instance, in the preparation of recorded television programs where the fact that the magnetic sound records do not need processing is a great attraction.

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Improvements in Large-Screen Television Projection

By T. M. C. Lance

Cinema-Television, Ltd., London, England

At the International Television Conference held at Zurich in 1948, Captain A. G. D. West read a paper in which he described the project which he had formulated for providing large-screen television to cinemas in London. In this paper he discussed the sources of program material, the distribution plan, the installation in the cinemas and other features, including the need for higher definition and the study of audience reaction.[1]

Previous Demonstration

After Captain West had read his paper at Zurich he pressed ahead with the objective of showing realistically the salient points of his plan for cinema television in a series of demonstrations to many interested bodies at a cinema in Bromley, Kent.[2] Each of these demonstrations included programs built up partly from the B.B.C. transmissions and partly from our own film scanner and studio at Sydenham.

The press comments were highly complimentary, and Captain West was extremely enthusiastic over the opportunity given to Cinema-Television to bring our equipment to Milan and demonstrate it in cooperation with the Marconi Company at this great Exhibition.

During the last year our technicians have had many second thoughts, some of which have been incorporated in this first design of equipment and others have still to be further experimented with in the laboratory. We have also learned much about the performance of this unique type of equipment in theaters, about the presentation of television programs and the problems of meeting the stringent conditions imposed by the public safety authorities.

It is against this background that I am presenting my paper today. I propose to indicate the general arrangement of the projector being

Reprinted, with a few parts omitted, from *British Kinematography*, vol. 15, pp. 178–190, Dec. 1949, by permission of *British Kinematography* and the author. The paper was read at the International Television Congress at Milan on September 13, 1949, at which it was followed by a demonstration of the equipment, in conjunction with Marconi transmitting equipment.

demonstrated here in Milan, to describe some of the improvements made since last year and to consider future work for the extension of these improvements.

Reception Requirements

The first essential requirement for the projector was to be able to receive either programs of national or sporting interest through the B.B.C. Television Service, or supporting or similar programs over the cinema organizations' private circuits.

While the Television Advisory Committee has laid down that in England the standards of transmission for the broadcast television service will remain fixed for a number of years, the standards selected for the cinema's own circuits are at present their own concern. The opportunity will, therefore, be taken to increase the number of lines and the bandwidth in order to reduce the cause of the major criticism of large screen projection.

The dual transmission necessitated the receiver operating first on the 405-line, 2/1-interlace standard transmitted from Alexandra Palace in North London on 45 megacycles/sec, and alternatively on the 625-line 2/1-interlace standard transmitted from the Crystal Palace in South London on 480 megacycles/sec.

We have approached this problem in two ways. Firstly, the receiver has been designed to receive the 480 megacycles/sec as a superheterodyne having an intermediate frequency of 45 megacycles/sec, which can be brought into operation as a straight receiver by changing aerial inputs when program sources are changed. Such cinemas would be fitted with a double aerial system. In this system the choice of program is the responsibility of the individual cinema exhibitor.

Short-Wave Relay System

The second and more interesting proposal is to receive the B.B.C. program from the Alexandra Palace at a conveniently placed relaying station and retransmit both programs to the cinemas over the 480-megacycles/sec circuit. This may prove a solution to the problem of interference from automobiles, electric signs and machinery in the West End theater district, because on the higher frequency a better signal-to-noise ratio may be expected through the use of directional aerial systems, particularly if at a later date a higher frequency is allocated to this new service.

This second system has the great advantage of bringing the whole television circuit under the control of one program director, so that

preselected introductory material can be transmitted before an eagerly expected event the nature of which does not allow of accurate timing. Thereby one of the criticisms of instantaneous projection in comparison with the intermediate film method of large screen television is removed.

The relay station chosen for the first experiments stands on the highest ground in the South of London, and our aerials are located on the top of a water tower in the grounds of the Crystal Palace, giving an undisturbed coverage of the London basin containing most of the suburbs, and particularly the West End area.

I would like to remark that it is a peculiarity of English television that, while being so eminently modern, it seems to be located in nineteenth-century palaces, the Alexandra Palace and the Crystal Palace, neither of which is in fact a palace and one of which does not now exist.

Construction of Equipment

The circuit of the receiver and the video chain of the projector are similar to those being described by Mr. J. E. B. Jacob in a separate paper to this convention.[3]

Figure 1 is a block diagram of the projector which shows considerable simplification over that shown last year.

To meet installation requirements the equipment is divided into four groups of units:

1. The units contained in the projector itself, which is located in the auditorium and should for this reason contain as little equipment as possible;
2. The units contained on the racks in the television operating room, which can be remote up to 100 ft from the projector, and by virtue of the separate picture monitor and indicating instruments need not be in a place where the large screen can be seen by the operator;
3. The high-tension unit which can be located anywhere within the cinema building; and
4. A small control unit which can be installed in the auditorium or the projection box at which small adjustments can be made to the picture quality, brightness, electrical focus and sound volume.

Video Chain

The function of the main units in the video chain is self-explanatory from an examination of the diagram. It will be noted that a gamma corrector is included. This is only at present an approximate correc-

tion for the nonlinear characteristics of certain studio cameras used in the transmission and can be cut in and out at will by the operator. Further work is planned in the design of this corrector as it may be desirable to have a variable gamma control.

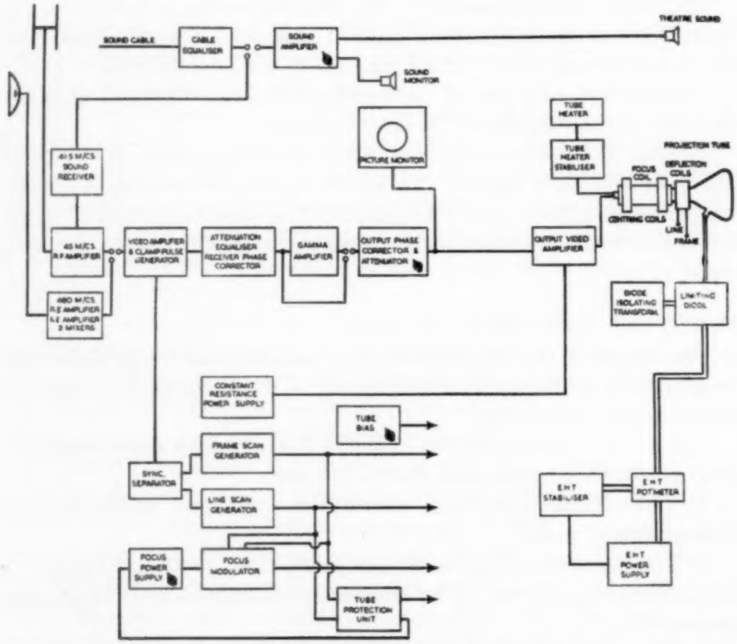

Fig. 1. Block diagram of projector system; power supplies and stabilizer are omitted for clarity.

Position of Projector

The design of this projector was commenced with certain experience and knowledge gained from operating a smaller projector with a half-scale Schmidt system.

We knew that larger optical systems could be designed and manufactured, and would give a resolution good enough for 625-line definition, and we also knew the luminous efficiency of our phosphors.

We decided that as much of the electrical equipment as possible was to be placed outside the auditorium for reasons just given, but where should the projector itself be placed? A survey was made of a large number of London cinemas; as Captain West showed last year,

most London cinemas have a circle, and the film pictures are projected down from the operating box at steep angles to the screen, having sufficient depth of focus to accommodate the variation in projection distance and sufficient illumination to allow the use of nondirectional screens. The Schmidt system for television, however, cannot be more than 10° off normal axis to the screen, so that in most cinemas the television projector must be located either on the front of the circle or on the floor of the auditorium. The front of the circle or balcony is, of course, the ideal position, but the throw distance is peculiar to each cinema and such an installation would in general call for individual "tailored" design of the optics. The cost and time occupied to complete and manufacture each optical system would, under these conditions, be prohibitive.

The suggestion has been made that to maintain projection normal to the screen the projector could be hung from the roof on a hydraulic cylinder, which would lower it into position when required and retract it when the film projector was operating; but there are very few cinemas in London where this device would not obscure the viewing of at least 20% of the audience.

Optical System

The decision was made to standardize on a 40-ft throw from projector to screen, and the system designed by Imperial Chemical Industries, Ltd., to our specification, consists of a mirror 27 in. (68.5 cm) in diameter, and a correcting plate which has an aperture of 18 in. (45.7 cm).[4] The speed of the system is $f/1.14$, the magnification being 27.7, which, to cover a screen diagonal of 20 ft requires an image on the cathode-ray tube of 8.66 in. diagonal. The angular field of the optical system is 14° each side of the axis.

Cathode-Ray Tube Assembly

Figures 2 and 3 illustrate the general assembly of the cathode-ray tube and optical system.

1. The 27-in. diameter glass mirror with the front surface aluminized and weighing 85 lb (38.5 kg) is supported in rubber-lined clamps. These clamps are arranged so that the lower two which bear the weight of the mirror are spaced at 45° each side of the vertical, as with this disposition there is the minimum distortion of the mirror due to its own weight.

2. Is a black shield of the same diameter as the face of the tube placed on the axis of the mirror to prevent reflection of light back from the tube onto its own face, thereby reducing contrast in the picture.

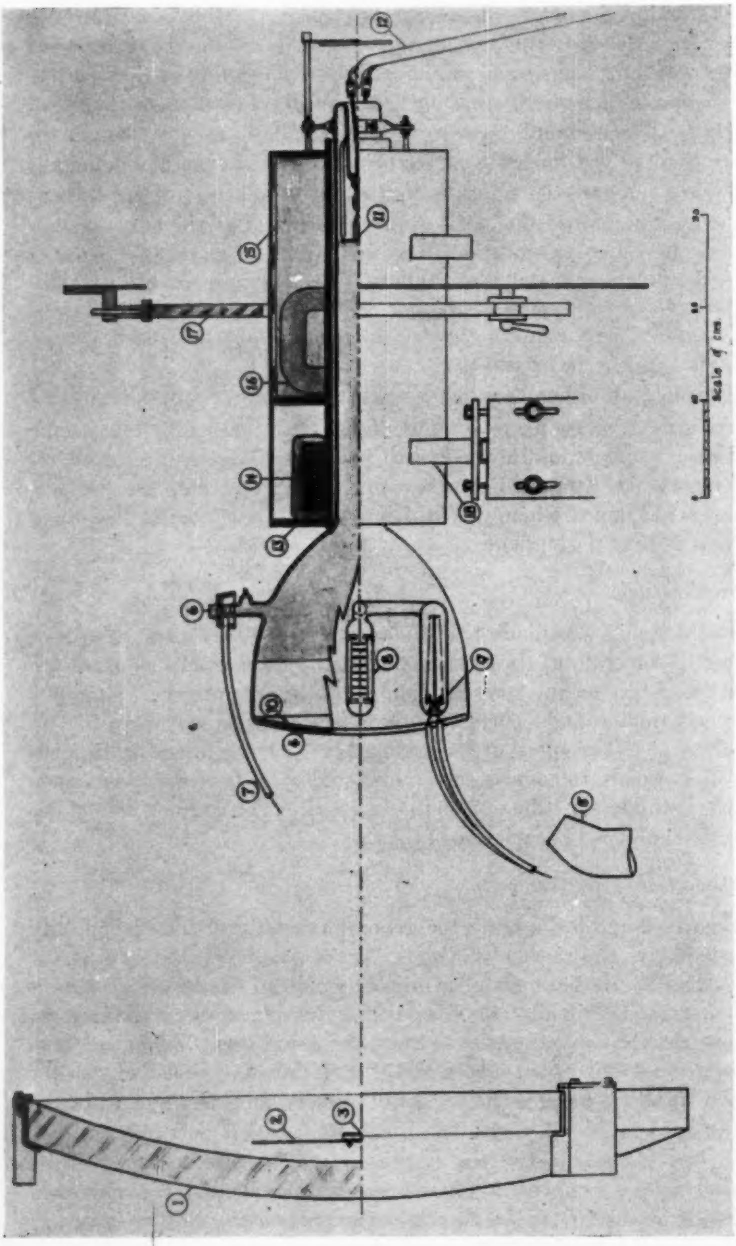

Fig. 2. Cathode-ray tube and optical system.

3. On the center of this plate is a selenium photocell which measures the average brightness of the picture and the reading of which is indicated back on the control equipment. This cell is used to indicate the average beam current, as all tubes are calibrated in the laboratory and marked with the reading of the photocell current corresponding to 1-ma beam current of the tube.

4. Is the face of the projection tube. This is an optically polished hard glass disc, the radius of which is approximately half the radius of the mirror. This plate carries the phosphor which is bombarded by the electron beam on one side, and to restrict the temperature rise of

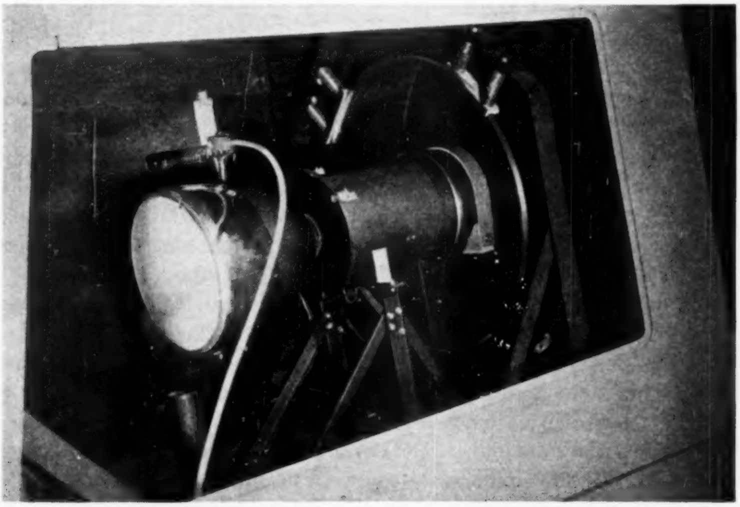

Fig. 3. Assembly of cathode-ray tube and corrector plate.

the phosphor, air at room temperature is blown across the face from an air nozzle. In the future it is planned to treat the outer face of the tube with an antireflecting coating.

5. Is the air nozzle, the design of which is quite critical to give uniform cooling over the whole face without noise. These two requirements go against each other, and a compromise has been found which is reasonably successful on normal television programs.

6. Is the anode connection to the tube made through an internal wire connection welded to a large platinum disk pressed into the inner surface of the glass envelope. The size of the disk is sufficient to ensure a low resistance contact to the graphite internal coating of the

tube. The tube is exhausted through the side tube carrying the anode connection.

7. Is the lead-in cable which is polythene-insulated. The diameter of this cable is surprisingly small, but on d-c conditions is adequate for 60 kv without trouble.

8. Is one of the two getter tubes. This one contains 12 batalum getters which can be fired by high frequency. The first is fired when the tube is manufactured and first sealed to the pump. At certain periods during life two or more additional getters are fired to maintain a good vacuum.

9. The second getter tube contains a zirconium wire getter which is continually heated during the running of the tube and the use of which has been found very advantageous. Unfortunately since the getter is near the anode coating it is necessary to maintain it at anode potential which involves a heating transformer insulated to full anode volts and two extra H.T. connections.

10. Is the electron-permeable aluminum coating applied to maintain the phosphor at anode potential and prevent "sticking," and which also considerably improves the contrast of the picture by obscuring internal reflection of light. The presence of the aluminum film also enables us to use a bright tungsten cathode, and the light from this, which is considerable, is also obscured.

11. Is the gun assembly which will be described separately, but attention is drawn to the heavy connectors necessary to maintain stabilized heater voltage with the heavy current of 14 amp required by the tungsten strip cathodes.

12. Is a small air jet, which is directed into the pinch, for the purpose of cooling the pinch and copper lead-out wires. Note that the assembly ends with an obscuring disk to prevent the light from the cathode falling directly onto the viewing screen.

13. A crucial point of the design is a thick polythene insulating sleeve tested to withstand 100 kv to earth, which provides the main insulation between the tube and the scan and focus coils which are at earth potential. Initially we relied on the glass neck of the tube to provide this insulation, but although each piece of glass was given a prolonged test at double working voltage we had many losses of tubes due to the puncturing of the glass after a few hours' run. The insulating sleeve is welded to a disk of the same material which protects the scan coils against flash-over from the outer surface of the glass on damp days.

14. Is the deflection unit. This consists of four windings on an iron-toothed stator having 30 teeth. In order to obtain the insulation

required the minimum wall thickness of the sleeve under the scanning yoke is 6.5 mm, and the problem of supplying sufficient scan current in these coils is very difficult, particularly at 15 kc, which is the line frequency for 625 lines, and also as the coils appear at the end of a long cable.

15. Is the focus coil. This is a complicated and costly unit. It consists of a long solenoid embracing the electrode system of the tube and having eight parallel windings so as to give the minimum practical resistance. The focus current is modulated at line and frame frequency, a worth-while improvement for high-voltage tubes having large deflection angles.

16. Is two sets of deflection coils, one used to center the beam in the focus coil and the other to center the scanned area or raster, on the face of the tube with the optical system. This electrical method of centering removes the need for accurate mechanical adjustments and greatly facilitates the realignment of tubes when these have been changed. In the same way we have found that only one in four of the tubes requires readjustment for the centering in the optical system to allow for the axial alignment of the tube neck to face. When the center of curvature of the tube has been placed on the axis then the adjustment to center the raster on to the center of the viewing screen is very slight and can be made electrically.

17. Is the correcting plate. This is held in four grooved rollers, the upper two of which are spring loaded and the other two are on eccentric rollers so that the plate can easily be centered on the optical axis while maintaining its parallelism to the mirror. In setting up these large Schmidt systems we have found that the spacing between the mirror and the correcting plate is uncritical, and we may in future make the correcting plate easily removable for tube changing, as this would simplify the internal arrangements of the tube mount.

18. The tube is held in position by being pressed into the polythene sleeve in the front and lightly clamped by the screws at the rear. Thus tube and focus coil mount are inserted into the optical system as one unit when a change is necessary. The focus coil mount is carried in the optical system on two girders made to be very rigid in the vertical plane, but designed to obscure as little light as possible. These girders are supported at the ends outside the optical path on adjustable supports.

Construction of Cathode-Ray Tube

The next most important item of the projector is the cathode-ray tube. Continuous improvement has been made in the performance

of the projection tubes under the arduous conditions called for by the specification. The tube produces 900 lm of luminous flux at 50 kv and a beam current of 5 ma. On a television picture the average current is generally about 1–1.5 ma. with peaks between 10–15 ma.

Figure 4 shows the external appearance of the projection tube alongside the focus and deflection unit previously described. The optically polished and curved face, the double getters and the electrode system can be easily recognized.

The main body of the tube is a mould-blown glass bulb, and all the parts are constructed of the same boro silicate glass manufactured by Chance Bros. and known as "Hysil." The face is sealed to the bulb in a special jig, gas fires being used in the normal manner. All the glass is given a preliminary E.H.T. test to double the working voltage,

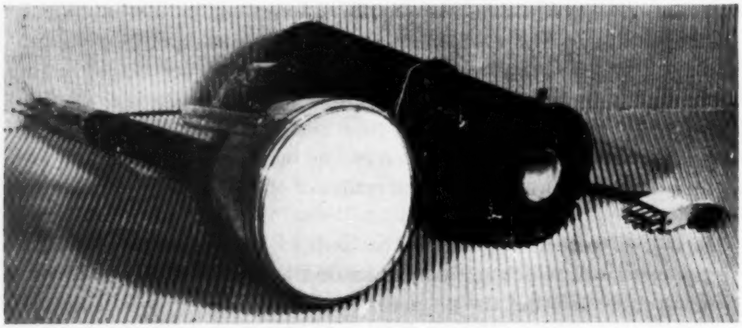

Fig. 4. Projection tube and coils.

as many failures have been traced to minute bubbles in the neck ionizing under working conditions and bursting.

Electrode System

The tube is a simple triode with the anode and modulator carefully cleaned and polished to reduce point discharges and cold emission at 50 kv.

The main problem was that of obtaining sufficient emission to give a focused beam current of 15 ma, and of the many cathode structures tested the most satisfactory was the flat top filament tape of pure tungsten. This was superior in that the unfocused beam was substantially circular, and hence made better use of the available focusing and deflection aberration-free areas, and also the spot passed through focus in a more symmetrical manner.

The dimension of the flat plateau of the cathode is approximately 1.5 mm square, and the thick tungsten strip was mounted in a rigid assembly with filament support radiators, which were found essential to avoid overheating the pinch, with resulting cracking. This cathode gives 10 ma for a 0.0025-in. spot at 50 kv, and requires a heater current of 14 amp at 2.05 v. The anode/modulator spacing is 3.5 mm, which results in a 9-deg beam angle for a drive of 430 volts at 1,040 volts cut-off. These spot sizes are made at 10 ma as a point of reference, but it should be noted that very little swelling occurred on increasing the beam current to 15 ma.

Pulse Testing

For testing the tubes and in particular for the measurement of focused spot diameter under full load conditions, a simple pulse modulation circuit was developed. It was desired to examine the spot sizes and shapes under a microscope for a series of experimental electrode systems. The specification calls for a 0.0025-in. (0.063-mm) diameter spot for 10-ma beam current at 50 kv. These projection tubes require about 1,000-v bias, and to avoid screen burning with a stationary spot a circuit was devised which provided as a drive a pulse of quarter-microsecond duration, variable in amplitude up to 1,000 v. In this a length of transmission line of 100-ohm characteristic impedance is terminated by a ladder attenuator of 100-ohm input impedance, through a spark-gap consisting of two points separated by an intervening gap, across which passes an electrically floating spoke rotated on a synchronous motor shaft. The line is charged through a high series resistance from a 3,000-v source, and when discharged by the gap gives a square pulse across the attenuator. The latter is necessary to reduce the high charge voltage implicit in the spark-gap discharge, and is also convenient for applying varying grid drives as required.

Beam currents are measured by the standard slide-back method, with the modification that to avoid heavy loading of the tubes, the d-c measurement is taken by applying a similar but broader pulse derived from a trigger circuit with cathode-follower output. The beam current pulse resulting from this modulation is readable on an oscilloscope suitably calibrated. The apparatus is simple and has given satisfactory service.

Cooling

A series of experiments have been made on liquid cooling and air cooling the face of the projection tube. It was found that the light

output measured under peak white conditions dropped by about 10% when the temperature of the outside face was raised from 20 C to 100 C; the temperature of the screen material itself under steady-state thermal conditions was then about 90° higher than the outside temperature.

The main difficulty in the problem of cooling the phosphor is that the thermal conductivity of the glass is low. Unfortunately in order that the tube shall withstand the atmospheric pressure with safety, particularly considering the bending moment on the glass seal, we have to use a plate 5 mm thick. From the point of view of thermal conductivity the phosphor layer corresponds to an extra 1 mm of glass. If, however, the face seal could be made in a manner whereby the stresses across the joint were normal to the radius at that point then the glass could be reduced to at most a third of this thickness, thus reducing the thermal conductivity so that the cooling of the phosphor would not be a serious problem, and an increase in luminous efficiency could be expected.

Experiments with an air blower have shown that there is a good possibility of obtaining adequate cooling by this means, and we are experimenting in the design of a silent nozzle to give an air jet to maintain the tube face at room temperature.

Effect of Heat on Phosphors

Experiments made 18 months [early 1948] ago on the effect of temperature rise, show that the efficiency of the yellow silicate dropped by 50% at 120 C, which meant that for satisfactory operation the outside face of the projection tube would have to be maintained at a temperature of less than 0 C, and plans were seriously discussed for cooling the face by a liquid cell; the projector would then have to include a small refrigerator.

The improvement in the temperature effect brought about by 18 months' work in phosphor development is clearly shown in Fig. 5.

(*a*) Is for a blue sulfate which we were forced to use at that time in the absence of any other blue phosphor;

(*b*) Is the temperature characteristic of an early projection silicate; while

(*c*) Is the best projection silicate at present available.

It has become obvious to us that the design of the projection cabinet must be very carefully worked out to restrict the entry of dust and moisture. It may even become necessary that heaters will have to be included to prevent condensation within the cabinet when the apparatus is not in use.

If these precautions are not observed carefully, brushing and sparking will occur over all the high-tension insulators and surfaces of the electrical equipment, as well as on the optical components.

Phosphor Development

To the nontechnical observers of our projection demonstrations over the past 18 months, the principal improvement has been in the color of the picture. Formerly the picture was a greenish-yellow, now it is a blue-white, giving a good color contrast with the subdued red lighting demanded by the authorities for cinemas in England.

However, we still regard phosphor development as the most important item in our program. We have to date produced two components which give the required color with reasonable brightness

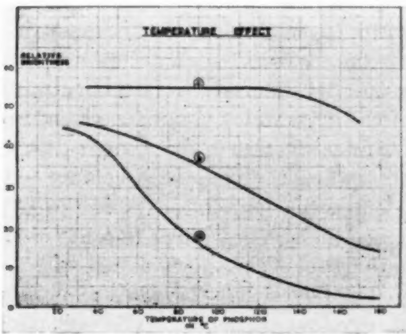

Fig. 5. Temperature effect on phosphors.

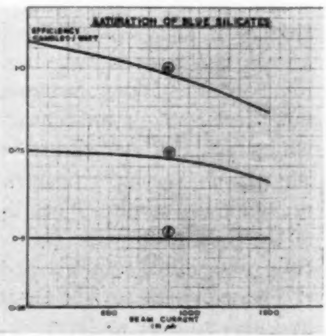

Fig. 6. Efficiency of phosphors.

when mixed, and which saturate to an equal amount, so that color changes with modulation are not noticeable. We have to a certain extent reduced screen burning, but there is still the serious disadvantage of outgassing of the phosphor during life to be overcome.

The control of particle size is also under investigation, as it is essential with a mixture of two phosphors to avoid color separation in the screen and to produce a uniform thickness of screen to assist the deposition of the aluminum film which has to lie in close contact with the phosphor.

The particle size of the two phosphors is under 5 microns, and the blue component is under 1 micron. The screen thickness averages 100 microns, and the density is about 8 milligrams per square centimeter. The aluminum film has a thickness of 0.1 to 0.2 micron.

The two components of our screen are both silicates, and approxi-

mately 800 experimental phosphors were made before we obtained a formula which has produced a blue silicate which shows no saturation effect under test conditions at 50 kv and a focused current of 1.5 ma. This is shown as curve (*f*) on Fig. 6. This test condition corresponds to a screen loading of 2 amp/sq cm; the peak white conditions will, of course, be ten times this.

The other two curves are (*d*) the most efficient blue silicate which can be obtained, which, it will be seen, has an efficiency roughly double our non-saturating phosphor at low beam currents, but also shows the highest saturation effect; and (*e*) which is the phosphor being used in the present tubes.

Aging of Phosphors

During life under projection conditions the phosphor suffers from a change of body color, and as this is observed as a darkening, it is known as "screen burning." This effect in some phosphors is reversible, and the darkening can be reduced by heat treatment; but there is also a darkening of the glass which is not reversible, and which has been assumed to be solarization due to the X-ray action on the glass. We have proved that when the glass is in contact with manganese-free phosphors this effect can be reduced to within 10% of the light absorption for a screen life corresponding to a life of the tube determined by the evaporation rate of the tungsten cathode.

The problems for the future are to overcome these adverse effects and also aim for an increase in luminous efficiency. The best phosphor in Fig. 6 has an efficiency of only about 1 c/w. We have always set the physicists the target of 5 c/w. We do not know if this is theoretically possible; but, if it is, then we can predict a big step forward in projection television.

E.H.T. (Electrical High-Tension) Supply

One very important item on which considerable work is at present being concentrated is the E.H.T. supply. With a triode tube of the dimensions given the regulation and stabilization of the E.H.T. demands very close tolerances if defocusing on load is to be avoided. At the same time precautions have to be taken to limit the energy from the power pack in the event of a discharge within the projection tube.

We are at present using large 50 cycles/sec voltage-doubling rectifier units which can give 10-ma continuous output at 55 kv. These are prewar in design and very cumbersome, but have given reliable service in a number of installations.

The regulation of the rectifier is between 65 kv on open circuit to 55 kv on 10-ma load, which is not sufficient. Originally we had stabilization on the primary of the transformer, but this does not eliminate ripple in the pack or take up rapid changes; a new circuit has therefore been evolved, shown in Fig. 7, which gives a control to 1%. This is built around the development of a special high-voltage stabilizing triode and a high-voltage limiting diode. The operating of these tubes is self-explanatory, but it is still essential to place the diode as close to the projection tube as possible in order to reduce the energy

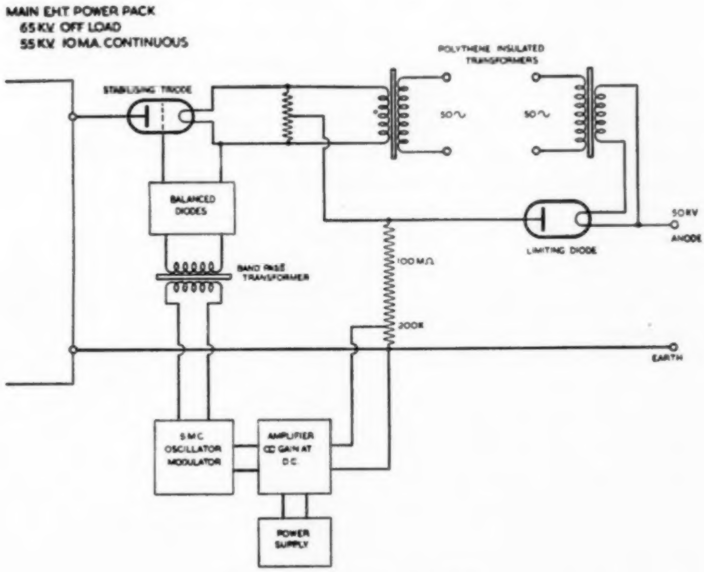

Fig. 7. E.H.T. supply circuit.

involved in the discharge of the cable capacity between the diode and the tube, within the tube.

Special high-voltage transformers of small dimensions have been evolved for this circuit. Their design has been made possible by the use of polythene-insulated wire and the application of the new technique of welding polythene screens over the windings.

Conclusion

To summarize, this paper has briefly described some of the many problems which have been attacked in the development of our

cinema television projector; improvements introduced during the last 18 months [up to a year ago] have been indicated and certain clues have been given to future developments.

In conclusion I wish to enumerate those of my colleagues to whom credit is due and gladly acknowledged for the solutions to the main problems involved in the cinema television projector. To Mr. T. C. Nuttall for general advice throughout our work; to Mr. E. D. McConnell for his consideration first of the optical requirements and then of the design of the whole of the electrical equipment excluding the receiver and video chain which Mr. J. E. B. Jacob evolved; to Dr. K. Samson and Mr. W. H. Buchanan for the development of the projection tubes and special triodes and diodes; to Mr. R. B. Head for his work on the phosphors and the many others within and outside our organization, who played their part as the happy team directed by our late chief, Captain West.

I must thank Cinema-Television, Ltd. for making it possible for me to be here in Milan and for permission to read this paper.

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Trends of 16-Mm Projector Equipment in the Army

By JAMES A. MOSES

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SUMMARY: The Army's use of 16-mm sound motion picture projection equipment during the past decade is outlined. A brief description of the Army standard 16-mm projector set AN/PFP-1 is given, with particular reference to features which provide increased light and sound output, higher sound fidelity and improved maintenance characteristics.

"To make available portable 16-mm projectors capable of giving satisfactory performances in the extreme sub-zero temperatures of Alaska, Iceland and Greenland, or the tropical heat and humidity of the South Pacific and the China-Burma-India Theater, as well as overcome the factor of wear and overuse at home in training millions of men and women in every phase of the complexities of w-a-r." THAT was the unprecedented assignment with which the Signal Corps and Army Pictorial Service were confronted in the early part of the past war. The time, money and effort expended and the degree to which this challenge was met is a story in itself, yet in presenting a comprehensive picture of the trends in Signal Corps 16-mm projectors during the past decade it will be necessary to elaborate upon certain exploratory work and resultant findings of the war years as well as to show numerous "flash backs" to trace the progress from early adoption and use, through World War II and the postwar development, testing and adoption of the new Projector Set AN/PFP-1-() which has been especially designed by the Signal Corps to meet the rugged requirements of the Army. Methods employed at present, or in future projects, for improving projection techniques, effecting greater care and proper handling of projectors or alleviating certain maintenance problems, yet maintaining extreme portability, will also be covered.

Although a satisfactory 16-mm sound-on-film projector appeared on the commercial market in 1931, for the next ten years the Signal Corps limited the scope of 16-mm projection activities to tests and experiments. However, with the passage of the Selective Service Act in 1940, induction of thousands of men into the military service and formulation of plans for the use of 16-mm training films in the audio-

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visual program, almost overnight the requirements for 16-mm films and sound projectors mushroomed into a large-scale operation. The Signal Corps Photographic Laboratory at the War College printed sizable quantities of 16-mm reduction prints from their 35-mm negatives and, as utilization of the new prints was contingent upon availability of suitable 16-mm projection equipment, local "off the shelf" procurements of several commercial models resulted. Selection of the 16-mm equipment was made after three weeks of testing during which time each type of projector was subjected to approximately 500 hr of continuous operation.

The turn of events on December 7, 1941, and entry of the United States into a shooting war initiated a greatly expanded program of photographic functions and operations within the Signal Corps. The Chief Signal Officer was assigned the responsibility at the outset for providing visual training aids, which included: the production and distribution of training films; combat photography for both military and historical purposes; morale of troops in presentation of entertainment motion pictures; and photographic laboratory, development and research. The scope widened further, with the progress of war, to cover all aspects of ground photography and, in some cases, it was necessary to take to the air. No precedents had been set to guide the task of supply that had to be accomplished in a comparatively short period of time; and the organization of pictorial activities and operation of procurement, storage and issue, starting with a system of trial and error, emerged into the Signal Corps' present Army Pictorial Service.

No planned procurements for projection equipment and supplies were in existence until late 1942, when Army Pictorial Service established the Photographic Equipment Branch to review requirements and initiate procurement action for various major items of projection and other pictorial equipment. Signal Corps specifications for projectors were practically nonexistent at that time. However, with the establishment of the Pictorial Engineering and Research Laboratory (PEARL) in early 1943, the Army standardization of projectors and other pictorial materials was begun. It was also a responsibility of the Laboratory to investigate, design and develop new types of photographic equipment. There the nucleus of what is now the Photographic Branch of Squier Signal Laboratory (SCEL), Fort Monmouth, N.J., commenced to make tests of 16-mm projectors and allied equipment, to write procurement specifications, training manuals and technical literature. Viewed in retrospect, it was a tiny and seemingly inconsequential organization in relation to the part it was des-

tined to play in one of the greatest photographic assignments the world has ever known.

During the period 1942–1945 the Signal Corps procured more than 16,000 16-mm projectors from several commercial manufacturers. This equipment offered the advantages of portability, ease of operation, low cost and availability. Naturally the maintenance and operation of several different types of projectors posed many problems in the field, yet these were due to the unusual requirements of the Army rather than any shortcomings of the commercial models. Cumulative utilization data show that during some of the most intensive thirty-day training periods more than 200,000 prints of 16-mm training films, almost a quarter of a million shows, were projected to military personnel; in addition, thousands of 16-mm entertainment films were being shown during this same period in overseas areas. Such usage is a lasting testimonial to the performance of the civilian model 16-mm projectors which were suddenly mustered into the Army and handed a seemingly impossible assignment. Equipment which had been designed for civilian use was often employed to project under conditions equal to and sometimes surpassing those recommended for 35-mm projection equipment. Performances at extreme temperatures and under other conditions of global warfare made the operation of each 16-mm projector of the Signal Corps an individual problem, with such factors as overuse, fluctuating electrical supply, fungus growth, corrosion and improper lubrication facilities contributing to the complexities. In spite of the climatic conditions, wear and frequent lack of parts for a particular type of projector, no difficulties arose which could not be overcome by improvization, local fabrication or substitution. For example, if exciter lamps were not available, jeep and motorcycle tail lamps were modified and used instead of the regular exciter. This and many other ingenious methods were responsible, time and again, for "keeping the show going."

The importance of properly trained operating and maintenance personnel was recognized from the outset and resulted in establishment of projectionist schools in all film libraries and exchanges and projector repair shops in centrally located spots in the Zone of the Interior and theaters of operations. Pickup and return of equipment and films were restricted to duly accredited graduates from the projectionist schools. These licensed operators were also authorized to replace lamps, belts, fuses and tubes, and to clean and lubricate the projectors. Equipment requiring higher echelons of maintenance was sent to the projector repair shops. These preventive

measures greatly assisted in minimizing damage to both equipment and films.

Although no 16-mm projector, designed for military use, was produced during the war, the models delivered to the Army during the later years of World War II represented a considerable improvement over their prewar counterparts.

The first move toward development of an entirely new 16-mm sound projector was the creation of the "Joint Army-Navy Specification, JAN P-49" on May 31, 1944. Although the JAN Specification assured the performance characteristics required for military use, it provided no means of standardization or interchangeability of parts, between successive procurements. The importance of parts uniformity and interchangeability was already being noted because of recurrent problems of the field in attempting to satisfy the maintenance requirements of several different types of projectors. This was further influenced by such accessory circumstances as: (1) the fact that replacement of existing equipment was not anticipated for a

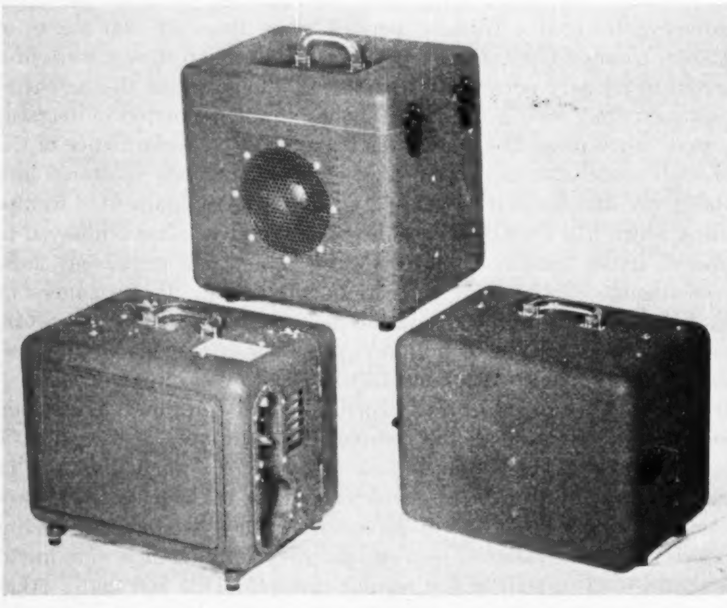

Fig. 1. Projector Set AN/PFP-1-() 16-mm motion picture sound equipment.

minimum of three years; (2) factual experience had proven that maintenance demands increase with the age of the equipment.

The JAN P-49 Specification was used as a basis for the Signal Corps Development Specification SCEL 4001. On May 2, 1946, a contract was awarded to the DeVry Corporation for development of a 16-mm projector designed primarily for Army use. Experimental models of this equipment were delivered to the Signal Corps Engineering Laboratories in December, 1947, where subsequent engineering tests resulted in a number of minor modifications. In January, 1950, modified test models were received by SCEL and these were made available for extensive service tests which were conducted under cognizance of Army Pictorial Service Division, Office of the Chief Signal Officer. Accumulation of the test data was effected by a series of tests held at Fort Myer, Fort Belvoir, Fort Meade, Fort Monroe and the Pentagon. An attempt was made to observe and evaluate the performance of the test models under all available conditions presently required by the Army. Continued use of the test projectors, under varied conditions, indicated improvements in light and sound output, sound fidelity and maintenance facilities. Such characteristics permit improved projection, in Department of the Army theaters, recreation halls, etc., to large audiences. The test models were used for both single unit and dual projection to various size groups, in film library projectionist schools, in film library maintenance shops, and were issued to units for showing Army training films under actual classroom conditions, in exactly the same manner as is employed for utilizing present 16-mm equipment.

A "Questionnaire" was prepared and issued to all units testing the new models. This form requested the users to indicate either "satisfactory" or "unsatisfactory" about the following: picture brightness and image quality on matte screen, sound quality and volume; ease of threading; ease of adjusting projection lamp for maximum uniformity and brightness; lens focusing adjustment; tilt adjustments, rewinding operation; switching arrangement and convenience in operation; change-over operation, amplifier controls; lower loop setting device; framing adjustment; picture gate closing; noise of projector mechanism; flutter content; installation, servicing, cleaning and/or sufficiency of projection and exciter lamps, condenser and projection lens, aperture and pressure plates, sprockets and rollers, fuses, belts, reel arms and attaching cables; size, weight and ease of carrying; and over-all physical design and construction of the equipment.

A consolidation of the test data submitted by the users indicated unanimously favorable comments on all items of major importance and was so conclusive that the few minor modifications and changes made necessary by the test report did not require further testing before final adoption of the equipment. On February 27, 1950, the Projector Set AN/PFP-1-() was classified standard type by Signal Corps Technical Committee action.

Before presenting further information about requirements for certain features included in the newly developed equipment, it is best that a description of the projector set AN/PFP-1 be given (Fig. 1).

This three-package unit consists of a projector, 20-w amplifier and speaker, with a screen and other accessories included as supplementary

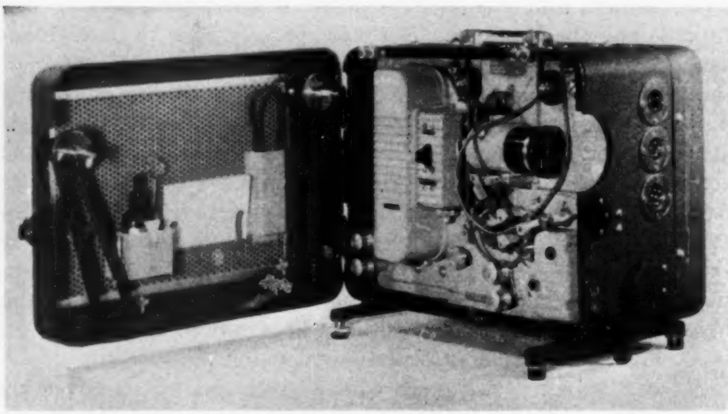

Fig. 2. AN/PFP-1-( ) Projector Component; case door open, showing location of reel arms, spares and accessories.

items in the set. The equipment has withstood all tests pertaining to severe temperature and humidity conditions. The projector is released expressly for use with incandescent lamps; however, provisions have been made for use of a supplemental light source where greater illumination is required and this unit will be portable in nature and packaged in a fourth case. In development, particular attention was given to the corrosion protection of the projector, amplifier and loudspeaker. Where corrosion-resistant material was not practical due to design limitations, suitable treatment was given the material to assure its being satisfactory and durable. Basically the projector machine mechanism is comprised of a central casting of aluminum which is

treated so as to afford the maximum protection from corrosion. The use of aluminum affords a weight reduction which is essential in order to meet the portability requirements and still have adequate strength and minimum vibration.

The general design of the projector (Fig. 2) is such that it features replacement by assembly and subassembly, it being understood that a motion picture projector is essentially a precision device and that frequently personnel involved in the maintenance of the projector would be insufficiently trained to make a basic mechanical replacement where such replacement involved a high degree of mechanical skill. This resulted in making an assembly of the motor and gearbox and a major assembly of the soundhead, so as to allow storage of this unit

Fig. 3. AN/PFP-1-() Amplifier Component; cover removed, showing location of photocell cable, changeover harness and bridging cable.

and rapid replacement where the essential film and test instruments are not available for its correct alignment after repair.

The shuttle and cam comprising the intermittent movement are accessible from the front of the projector and can be replaced by relatively inexperienced personnel in less than a half hour. Further, it is unnecessary to remove any other part of the projector mechanism in order to gain access to the intermittent. This system is designed to permit film movement with two damaged or torn perforations and framing of the picture on the screen without shift of the projected aperture.

The amplifier (Fig. 3) features complete accessibility for replacement of defective parts or for checking of its performance electrically.

It, too, is constructed in accordance with component requirements and is suitably protected against corrosion, fungus and high humidity conditions.

The loudspeaker (Fig. 4) is an 8-in. permanent-magnet cone speaker which has withstood all tests with regard to mechanical strength, vibration and shock. The case-deadening material utilized is glass fiber pads forming an acoustic sound-deadening material impervious to the effects of extreme temperature, humidity or fungus.

Close attention has been paid to operational convenience throughout the entire design and the threading of the projector is straightforward with a minimum number of sharp turns. Three basic features have been incorporated into the projector for greater convenience. They are: (1) location of a threading knob on the side with index marks to indicate when claw is projecting, thereby facilitating matching the perforations to the shuttle teeth; (2) lower loop length adjustment is provided by a small diagonally facing knob located under the intermittent and change-over housing. This device permits correct presetting of the lower loop for film having varying degrees of shrinkage or wear; (3) an exteriorly operated loop setter. The lower loop can be reset while the projector cover is closed by pressing the reset button on top of the projector. As has been noted above, almost all of the components are removable as assemblies. Where such is not the case, they are mounted on sub-panels to allow movement without wiring discontinuity.

The projector proper is operative from either direct current or alternating current of voltage ranges from 105 to 129 v. The amplifier is a 60-cycle a-c unit operating over the same voltage range. A converter is required where direct current is the normal supply. The projector and amplifier will perform satisfactorily on either 50 or 60 cycles without change of the mechanism and the equipment performs equally well at both frequencies. The projector motor itself utilizes an electrical centrifugal governor for its speed control, the cooling or associated motor not being governed but of the same essential electrical components as the projector motor.

The projector is provided with a one-point central lubrication system containing an oil supply adequate for 100 hr of continuous operation. The intermittent shuttle and cam are supplied by this oiling system and no grease is required for their operation.

The electromagnetic change-over system functions without relays and is motivated by a press button located in the rear of each projector on the switch panel. By these means projector change-overs are

accomplished instantaneously. The change-over wiring is supplied as a harness and normally carried with the amplifier since the change-over is designed for operation on alternating current. An exciter-lamp type of change-over is used for sound and a dowser interposed between the first condenser and light source for the picture.

The normal light sources for the projector set are 750- and 1000-w projection lamps, medium prefocus base, 115-v, 25-hr life. To overcome the element of error in the prefocus base, a mechanical lamp

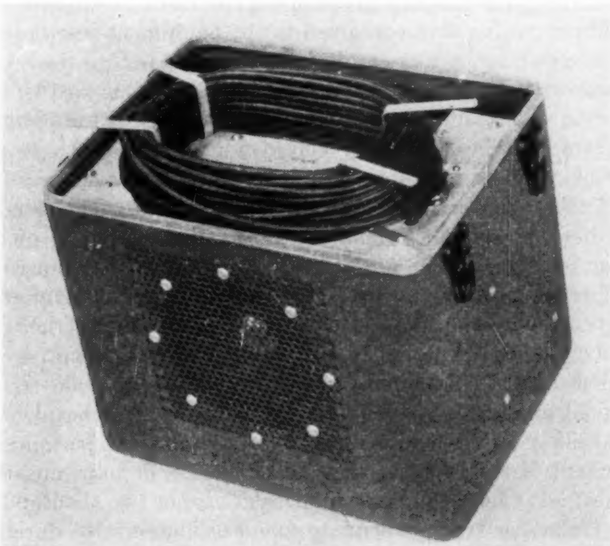

Fig. 4. AN/PFP-1-() Loudspeaker Component; showing cover removed and location of cable.

base shifter is built into the projector so that the whole lamp assembly can be shifted horizontally and laterally in such a manner as to assure maximum screen illumination. Once the lamp is properly positioned it will require no further attention throughout its life.

The soundhead used in the projector was developed under specifications which set standards equally as rigid as those established for 35-mm reproduction. The exciter lamp is made readily accessible by the removal of the exciter-lamp cover. Light from the exciter lamp, as projected through the optical system and modulated by the film, is

picked up by a prismatic type of light pipe and transmitted to the rear of the soundhead casting where it is reflected to the lead sulfide photocell, which is rigidly mounted on the soundhead casting, thus eliminating all photocell microphonics.

It is fitting, at this point, that credit be given to the Society of Motion Picture and Television Engineers and its committees for making available to the Armed Forces and to industry a fine series of test films without which the projection equipment just described could never have been developed, since it is essential first to have the tools for measurement before any product can result.

The improved features contained in the equipment just described did not come about by mere arbitrary action, but each is the result of considerable study regarding the relative potency of particular requirements. Throughout the entire development program, however, two factors have been carefully considered. These are: (1) maintenance of Army 16-mm projectors had been difficult and costly because of the lack of assemblies and subassemblies. This condition was further aggravated, in many cases, by the absence of qualified projector repairmen; (2) average attendance and conditions under which films are projected in the Army show definite needs for greatly increased sound and light output and higher sound fidelity. It should be re-emphasized that factual information resulting from evaluations made during what was the largest full-scale training, educational and entertainment film program ever undertaken, has provided immeasurable guidance on many matters pertaining to development of the Projector Set AN/PFP-1. Perhaps unsatisfactory showings of entertainment films to groups of two thousand men in New Guinea or lack of adequate sound or illumination during the showing of training films in the Post Theater at Camp Hood, are partially responsible for increased sound and light output in the new design. Low voltages encountered in the Mediterranean, or the South Pacific, undoubtedly played a major role in the provisions for a compensator for fluctuating and low voltages.

The postwar period has made some interesting and helpful contributions, too. Continued increases in Regular Army film usage, together with that of National Guard, Organized Reserves and ROTC, further indicate the requirement for 16-mm equipment with greater sound and light output. Utilization data obtained by a consolidation of Film Library Reports for the period from October 1, 1949, through December 31, 1949, shows that Signal Corps films were shown more than 228,000 times to audiences totaling more than

17,500,000, or an average of 76 persons per individual show. This high average means that many of the showings were attended by several hundreds and even thousands.

The Army and the Signal Corps have not relied solely upon the development of a new 16-mm projector to improve conditions surrounding the use of Army training films. Other similar projects are:

(1) New Special Regulation, distributed in November, 1949, which outlines latest procedures to be observed in the operation of film libraries and film and equipment exchanges. This regulation includes a detailed course of instruction for 16-mm projectionists and covers proper care and storage of equipment;

(2) A new training film entitled *Technique of Good Projection* is in process of production. This film will impress the projectionists with the importance of adding a "professional touch" to Army projection. The outline for a second training film entitled *Principles of Operation of the Projector Set AN/PFP-1* is now being prepared; and

(3) Last, but of equal importance, is the Instructional Film Research Program in which the Army is participating along with the Navy and Penn State College in an effort to determine better the techniques which can be most profitably employed in the future to assure *better films* and their *better use.*

Foreign Versions

By VICTOR VOLMAR

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SUMMARY: Dubbing, subtitling and related production techniques are described. Spoken and written language rules and pitfalls are noted, and taboos are tabulated.

BEFORE OUR AMERICAN MOTION PICTURES can be exhibited to non-English-speaking peoples, they have to be either "dubbed," subtitled or narrated in the foreign language.

Dubbing is a tedious process of substituting words in the foreign language for those spoken by the players in English. It is important that the substituted speeches be as long as the original ones, and that the lip movement be the same, especially on the closing sound of each speech.

The prevailing system for dubbing in America has been that of making loops, one endless loop for each scene. Each loop is about thirty feet long and is played over and over again, while the foreign speakers listen carefully for their parts and may suggest changes in the wording. After a good deal of practice and a number of trials, they finally decide to attempt the recording. While the picture is run off silently, the sound shut off or heard on only one earphone, the members of the group speak their parts in the pretranslated foreign language. The scene is then immediately sent to the laboratory for developing and printing and is played back the next day, together with the music-and-effects track, with which it eventually will be mixed, i.e., printed together. The scene is edited, i.e., cut, or done over again, if necessary.

Several operations are necessary in order to subtitle pictures. Each picture has to be "spotted." Spotting is the fixing of the exact length and position of the subtitles. A no-splice print has to be secured for the spotter. With the print on a miniature combination of motion picture projector, screen and loudspeaker called a "moviola" (Fig. 1), on which the film can be played forward and back and stopped, the spotter enters, on a full continuity (a list of all the words spoken in the picture), the exact footage for each scene. Then he types what is called his spotting list and on it he condenses the dialogue in accordance with the footage for each scene, to enable the audience to read

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the subtitle as well as to look at the picture. The spotting list, on which the spotter also indicates who is speaking to whom and gives additional information and explanations necessary for comprehension of the action, is then given to the various translators who translate the

Fig. 1. Spotter Nat Hoffberg, with the latest type Moviola. Hoffberg, who started in the business many years ago, did his first spotting from Vitaphone records when frames destroyed in the picture had to be replaced by black frames, in order to maintain synchronization.

condensed dialogue into their respective languages, not exceeding the footage allowed for each subtitle.

Cards or a continuous roll are then printed with the foreign subtitles, and the laboratory, by means of a pre-cut control strip which ad-

vances each title at the proper footage, makes a full-length title negative (Fig. 2). Short or Debrie title negatives, which are cheaper and necessitate only a short title roll, because each title is printed only once, are less popular now, since there is as yet no machine which will make them adaptable for 16-mm prints. The procedure may vary somewhat with each laboratory.

Before starting to make the prints in the foreign languages, a foreign main-title background negative is needed, i.e., the beginning of the picture without all the titles and credits, so that the main titles and credits can be superimposed on it in the foreign languages. From the opening of the first scene, the picture is printed like any domestic print, except that the foreign title negative is run through the printer at the same time, so that the foreign titles (black on the title negative) appear transparent on the finished print and white on the screen. The sound track remains the same for the entire picture, except where there are narrations, which may be substituted in the foreign languages.

In addition, some companies first make a full-length negative of "scratch titles" in English, usually typewritten, which is then printed together with the picture negative and the resultant print is projected for examination of length and convenience of titles.

In the case of color prints, subtitles are added by various processes. Either the subtitles appear in a black frame at the bottom of the picture, or the titles are created by taking the emulsion off the base, by hot stencil, which burns the titles out of the color, or by the more popular stencil-etching process, in which the titles are etched out of the color The last-named process was particularly successful in an Alpine picture, as the titles usually appeared on a white background, but the etching created a thin, colored line around each letter, which made it stand out perfectly.

Trailers follow the same procedure as pictures. The foreign trailer is printed from a trailer negative without lettering, plus a title negative, for which all large main titles and credits are photographed from hand-drawn cards, the same as the opening of a picture. The dialogue, translated in subtitles, is photographed from typeset printed cards (Fig. 3). The English sound track is usually kept for the foreign version, except where narrative parts may be substituted. Entirely new, independent trailers of important pictures may be made in the foreign languages, stressing in each the particular points in the picture that would especially appeal to that particular foreign-language audience.

Subtitling must be simple, direct and concise. Entire sentences

may have to be expressed in a few words which will fit into one, two or at most three lines at the bottom of the projected image. Difficult words and ambiguity must be avoided. To this end at least one large company, from time to time, sends a selection of the most difficult and controversial titles to an outside translation bureau for their retranslation into English, to see whether they will convey the proper meaning.

Fig. 2. John Casolaro, of the C & G Film Effects Co., at the camera, photographing titles for superimposition. Title negatives for foreign versions are produced on this camera.

For some countries, such as Belgium, pictures are subtitled in two languages, French and Flemish. For others, such as Egypt, as many as four languages are used, with two sets of titles flashed from slides onto each side of the screen, with possibly a live or recorded narrator's voice in a fifth language.

Again, other countries, like Italy, Spain and Western Germany,

will permit only dubbed versions to be shown. They are also preferred in France and usually are done in France.

The system of narration mentioned above is particularly suited for the lesser-used languages, like Arabic, which many can understand but few can read. A sound track is made of a running explanation of the happenings on the screen and is mixed with the sound-and-effects track, and sometimes even with the original English dialogue, which is then heard in the background.

In examining the situation in the leading languages, we may turn first to Latin America, where Spanish is spoken with slight variations in vocabulary and pronunciation by nineteen nations (including Spain itself), so that it is impossible to assemble a dubbing crew to suit them all. This is one of the reasons why even the largest companies are abandoning the dubbing system in favor of subtitling, at least for Spanish and Portuguese. Another reason is that many foreign moviegoers, though they may not understand a word of English, still prefer to hear the players' real voices, especially when these are famous for diction and delivery. There are other foreign patrons who speak English and would resent it if the original dialogue were eliminated, and there are still others who go to the cinema not only to be entertained but also to learn English. It is probably no exaggeration to say that motion pictures, as an agent for the dissemination of the English language, rate second only to the presence of the members of our armed forces in many parts of the world.

Several foreign governments now see, in subtitling, a means of encouraging the far-flung masses to learn to read and write, and therefore insist on correct grammar and the latest spelling for each picture. Thus motion pictures contribute considerably to the eradication of illiteracy abroad.

Pictures made in Spain can be relied upon for having dialogue spoken in the pure Castilian of Spain, with hardly any slang. Slang is mainly the product of a metropolis, and Spain has no real metropolis. Both Madrid and Barcelona, the latter being Catalonian, besides, are cities of only one million inhabitants. The same is not quite true of pictures made in Argentina. These definitely bear the linguistic imprint of a big city, Buenos Aires. Mexican pictures, which in the past have been woven mainly around rural life, contain a number of Mexican expressions which are not readily understood elsewhere.

Spanish pictures made in Spain are linguistically acceptable to Hispano-American audiences, but American pictures, if they were dubbed by Spaniards, would not be. The Latin American objects to the "ceceo." There is something like a "neutral" Hispanic pronun-

ciation, that, for instance, of the radio broadcasters from this country and from the British Broadcasting Company. However, it is difficult to obtain such "neutral" pronunciation from all the members of

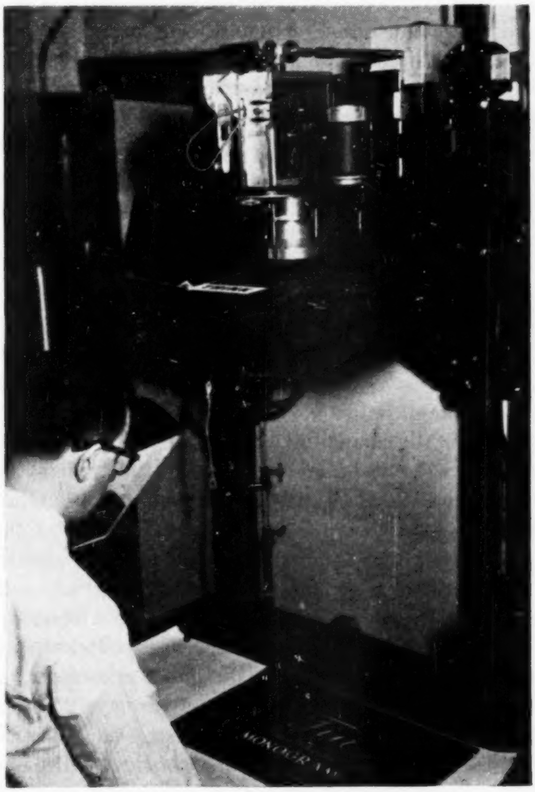

Fig. 3. Hugo Casolaro, of the C & G Film Effects Co., at an animation stand, which is used to photograph hand-drawn cards, inserts and stills for pictures and trailers, and on which optical effects can be achieved.

a dubbing crew. The audience usually is able to determine immediately whether the dubbed voice is that of a Mexican, an Argentine, a Cuban or a Puerto Rican. Furthermore, dubbing, unlike radio news broadcasting, demands the use of colloquialisms. A cow hand cannot very well speak like a college professor.

Even in subtitling pictures in Spanish there are difficulties. Names of plants and animals, especially, change from one country to another. Translators must guard against regional expressions and those that have a double, sometimes objectionable, meaning.

Portuguese is spoken with slight variations in Brazil, where in some remote regions the ancient Portuguese still prevails, the same as Canadian French still contains many archaic French terms. Portuguese spoken in Portugal varies considerably from region to region, Portugal being an older country. Vocabularies of Portugal and Brazil also differ, and subtitled versions are made with the Brazilian vocabulary, as the Brazilian audience is so much larger. If no separate version is made for Portugal, some companies send their translations to Portugal for checking and then change only those titles which would not be properly understood in Portugal.

The Brazilian and the Portuguese Academies recently agreed on a common, simplified spelling. Although it is far from universally observed, this simplified spelling is usually used in the subtitles, or it should be. The latest edition of the *Pequeno Dicionário Brasileiro da Língua Portuguêsa*, published in Brazil, should be consulted, and also, especially for the change of accents in the plural, the *Pequeno Vocabulário Ortográfico da Língua Portuguêsa*, the official work of the Academia Brasileira de Letras, and approved by the Academia das Ciências de Lisboa.

French dialogue, which adheres to the speech of Paris, invariably includes a good deal of the "langage populaire," the popular lingo, which is somewhat between real argot (slang) and French. Everybody in France uses it, even in the best circles. It is a terminology which is not contained in textbooks or school grammars, but which one must know if one wants to converse in French. Sometimes regional accent is mixed in (mainly the Southern, such as that of Fernandel, who is a Marseillais), but the body of the picture is always in French.

Dubbing is always done in the Paris pronunciation, which is about standard French, and French subtitles are in pure French plus the above-mentioned "langage populaire."

Italian films are invariably in pure Italian (Tuscan), unless there is dialect mixed in in spots. As in Spain, there is no slang in Italy, since the various dialects, which sometimes amount to separate languages, like Piedmontese, take the place of slang. Dubbing and subtitling should always be in pure Italian and should present no difficulties.

Though Dutch and Flemish are now spelled alike, the terminology varies in the two countries. Therefore separate subtitled versions are usually made, especially since Flemish always appears together with French subtitles since Belgium is a bilingual country. The pronunciation of Dutch differs considerably from that of Flemish, so that separate dubbed versions would have to be made for Holland and Belgium.

A similar situation exists for Denmark and Norway, where the written languages are about the same but the pronunciation varies greatly.

Swiss and Austrian audiences may resent it when subtitles and dubbing are done by Germans, as the terminology and the accent in pronunciation differ slightly.

Now a new problem has arisen in Indonesia, and at least one company is making versions subtitled in Dutch and Indonesian Malay, which is generally understood throughout all the islands, though each has its own language. Malay titles happen to be long, especially since the language forms plurals by repeating the nouns, i.e., orang is man and orang orang, men, so that the art of the translator will be to cut them down.

A few words may be added on the selection of foreign titles. These may be close translations of the original English titles, free translations, or altogether different. In many cases they have to be altogether different. A title like "Hellzapoppin," of course, could never be translated literally.

All foreign titles are accepted and registered by the Motion Picture Association, provided there is no conflict with the same or a similar title; or if there is, that an agreement has been reached with the conflicting company, so that, as a rule, no two pictures by American companies will be sent into the same territory with the same title. But there is no control over other than American pictures, and any title duplications with other than American pictures have to be adjusted locally.

It is not amiss also to point out that spotters, who are in a sense the foreign editors of a picture, and translators be men of general culture who, besides knowing at least two languages, should also have some artistic sense. A general or commercial translator or even a journalist usually cannot translate subtitles satisfactorily, at least not without some practice. It is desirable that the translator keep in constant touch with the intellectual life of the country or countries of his language, as he must be familiar with the latest developments in the lan-

List of Taboos

(See the last paragraph of the text for relative value of this list.)

	Superimposed titles	Dubbing before export	Any gun play	Excessive shooting	Riots in jails	Crime & gangsterism	Technique of crime	Murder	Executions	Corpses	Horror	Brutality	Bank robberies	Train holdups	Juvenile crimes	Cruelty to children	Rough treatment of women	Cruelty to Animals	Rodeo sequences	Any drinking scenes	Drunkenness	Drug habit	Kissing scenes	Excessive sex
Argentina																								
Australia												x									x			x
Belgium																								
Bolivia																								
Brazil								x		x														
Burma													x	x										
Canada																								
Ceylon																					x			
Chile						x																		
China (until 1949)																								
Colombia						x															x			x
Costa Rica[2]																								
Cuba																								
Czechoslovakia											x													
Denmark	x					x																		
Dominican Republic																								
Ecuador[3]				x		x																		
Egypt[5]							x		x		x	x				x		x				x		
El Salvador											x	x												
Finland																								
France[3]	x	x																						
French Indo-China																								
Greece					x	x																		
Guatemala																								
Haiti																								
Honduras																								
India			x																	x				x
Indonesia				x								x									x			x
Iran						x					x													
Iraq																								
Ireland																								
Israel[4]																								
Italy	x	x																						
Jamaica						x															x			
Lebanon																								
Mexico																								
Netherlands				x		x					x	x												
Neth. West Indies																		x						
New Zealand																								x
Nicaragua																								
Norway						x					x	x												
Pakistan																					x			
Panama																								
Paraguay[6]																								
Peru						x																		x
Philippines												x												
Poland																								
Portugal						x																		
Siam[6]							x		x			x						x				x		
Singapore[7]				x	x	x	x				x		x				x						x	x
South Africa						x	x		x			x			x	x	x				x	x		x
Spain	x	x																						
Sweden				x	x	x					x	x						x			x			
Switzerland						x						x												
Syria																								
Trinidad				x	x	x																		
Turkey																								
United Kingdom							x		x			x						x	x			x		x
Uruguay																								
Venezuela[6]																								

[1] Province of Quebec. [2] Practically no censorship. [3] Lenient. [4] Lenient but getting

List of Taboos (*concl'd*)

Immorality	Nudity	Divorce	Obscene story	Vulgar titles	Bad English	Spitting	Details of surgery	Mental Hospital scenes	Religious propaganda	Anti-Semitism	Attacks on country's religions	Support of superstition	Support of Zionism	Actor contributors to Zionism	Attacks on nation & distortion	Anti-Arab attitude	Anti-racial	Attacks on regime	Impersonation of the King	Attacks on royalty	Labor violence	Lauding capitalism	Resistance movement	
																		x			x			Argentina
	x				x	x															x			Australia
																								Belgium
																								Bolivia
																								Brazil
																								Burma
	[1]	x																						Canada
																								Ceylon
											x													Chile
												x			x									China (until 1949)
		x										x												Colombia
																								Costa Rica[2]
																								Cuba
																								Czechoslovakia
																								Denmark
																		x						Dominican Republic
		x																			x			Ecuador[3]
x	x			x	x						x				x	x				x				Egypt[8]
x											x													El Salvador
																								Finland
																								France[3]
	x																x				x			French Indo-China
																							x	Greece
																								Guatemala
											x													Haiti
																								Honduras
																								India
	x														x		x							Indonesia
																				x				Iran
															x	x	x			x				Iraq
	x	x													x									Ireland
																								Israel[4]
																								Italy
																								Jamaica
x											x		x			x								Lebanon
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																								Netherlands
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											x													Nicaragua
																								Norway
	x																							Pakistan
																								Panama
																								Paraguay[5]
															x									Peru
	x										x				x									Philippines
																						x		Poland
x																								Portugal
			x								x				x					x				Siam[6]
x					x						x			x			x						x	Singapore[7]
x	x				x						x								x					South Africa
											x							x						Spain
																					x			Sweden
																								Switzerland
																x	x							Syria
											x													Trinidad
	x								x	x					x		x	x						Turkey
	x				x	x		x	x															United Kingdom
																								Uruguay
																								Venezuela[6]

stricter. [5] No censorship. [6] Very lenient. [7] Extremely severe. [8] Severe.

guage, especially with popular expressions. One can imagine what effect it would have on an American audience if a soldier of World War II were called a doughboy.

In the tabulation herewith are shown taboos in the various countries of the world, including the English-speaking ones. This list was compiled mainly from issues of the "Motion Picture and Equipment Bulletin" of *World Trade in Commodities,* published by the U.S. Department of Commerce. It is necessary to point out that the number of checks after the name of a country do not necessarily form a criterion for its severity. These checks merely state on what grounds pictures have been rejected in the past, usually because they were found objectionable to an extreme degree under the particular headings. Other countries with fewer checks may be more severe, but as motion picture companies know this they will not even send pictures into these countries if they expect rejections, or they will edit the pictures in advance. For a few countries in the table the author has not found any recent, definite information, so there are no x marks.

A Progress Report of Engineering Committee Work

By F. T. BOWDITCH, Engineering Vice-President

The September Journal lists 19 Engineering Committees with a total of 313 members. More than 40 separate projects are presently under review by these groups; some have one project each, others as many as 10. So it is obviously impractical here to review all this activity in any detail. Instead, this report will be confined to a few highlights which indicate current trends.

One trend is the considerable increase in the number of committee meetings being held, in large part the result of the excellent coordination and secretarial activities of our Staff Engineer, W. H. Deacy, Jr. Ten such meetings are scheduled during the five days of this Convention, which is, as far as I am aware, a new high in this form of activity. Much of this is engineering survey work, such as that of the Screen Brightness Committee in its investigation of 100 typical theaters from coast to coast, the excellent work of the Color Sensitometry Subcommittee, the High-Speed Photography Survey, the study of air conditioning by the Theater Engineering Committee, and many others equal in importance to these few examples.

Also of major interest is the committee work in the field of standardization, where—to name only a few—typical projects now include the preparation of a new film leader suited to both television studio and motion picture theater projection, a method of calibrating and marking camera lenses in terms of light transmission, the specification of a standard base for a new projection lamp, the dimensional characteristics of magnetic sound tracks, and the continued work in the field of cutting and perforating motion picture film.

We have yet to find a satisfactory answer to the basic problem of when to standardize. An excellent time would be early in a new art, before machines and methods in different companies become fixed in conflicting fashion, but basic information is meager then. Unfortunately, too, the need to standardize is not usually anticipated until actual conflict arises, and the resolution of the differences cannot help but cause economic loss to someone. Standardization becomes extremely difficult in such a case, although it is a pleasure to report increasing evidence of cooperative give-and-take in these matters. The

Presented: October 17, 1950, at the SMPTE Convention at Lake Placid, N.Y.

extremely important function of the Society in providing a neutral meeting ground cannot be underestimated and everything possible is being done to maintain this impartial atmosphere.

Present trends are also represented by the new Engineering Committees formed this year. One of these is the Optics Committee, under Dr. R. Kingslake, which is presently concerned with the lens calibration standards and the dimensional properties of projection lenses. Our newest Engineering Committee is the Test Film Quality Committee, under F. J. Pfeiff. It is charged with the responsibility of maintaining the high production standards which are an essential part of this very important activity of the Society. Finally, the increasing importance of the engineering work of the Society in the television field has been recognized by a realignment and expansion of our committee organization there. The Theater Television Committee, under Don Hyndman, of course continues, and to this have been added new ones: Television Studio Lighting under Richard Blount; Films for Television under R. L. Garman; and, jointly with RTMA, Television Film Equipment with F. N. Gillette as chairman, representing RTMA, and E. C. Fritts as Vice-Chairman, representing SMPTE.

The real strength of the Society, which determines how well we continue to be regarded as the foremost technical group in matters concerning television and motion pictures, lies as much in this work of the Engineering Committees as it does in the high quality of the papers presented at the Conventions and in the Journal, and in the many important management functions conducted through the Board of Governors. The writer is indeed grateful to the many Engineering Committee chairmen and members involved, and to the Staff Engineer, who discharge these important responsibilities so capably.

Biological Photographic Association

In 1931 a group of some thirty medical photographers met in New Haven to exchange ideas about their work. As a profession, theirs was one of photography's youngest, but these delegates had worked in it sufficiently to believe in its importance. They were also discovering that medicine's needs for new types of illustrations could not be filled by workers who remained each in his own darkroom, unaware of the experiences of others.

Medical advances were posing such problems as (to mention some in the motion picture field alone): records of surgical procedures made under aseptic conditions; films showing the movements of internal organs such as the vocal cords, the eardrum, the stomach; cinemicrographs of minute organisms; lapse-time photography of growth, as in the development of bacterial colonies; high-speed records of reflex motions; serial photographs of the fluorescent screen, etc. Much of this work entailed the use of precision instruments; all of it called for careful experimentation. Obviously, a clearinghouse was needed for the exchange of information.

Because medical photography is so closely allied with clinical and research medicine, the delegates decided that their organization should be formed as a scientific rather than a trade society. Its aim should be the advancement of photography through the free exchange of ideas. Membership is open to any individual, professional or amateur, who applies photography to the study or teaching of science. Since there is an interrelation of problems over a wide field, the society's scope has not been limited to medicine alone. The organization was named the Biological Photographic Association, the term "biological" covering all branches of science concerned with living forms.

In its subsequent years of growth, the BPA has developed in accordance with these charter plans. It is an incorporated, nonprofit organization, whose members are scientists, teachers, designers of precision equipment, naturalists, and, of course, a growing core of biological photographers. Chapters have been formed in Boston, Mass.; New York, N.Y.; Philippi, W.Va.; Cleveland, Ohio; Chicago, Ill.; and Los Angeles, Calif. Foreign members are eligible and are increasing in number.

The Journal of the Biological Photographic Association is at present in its eighteenth volume. It is the only journal which concentrates on the now well-established field of biological photography. Published quarterly, it comprises a volume of about 200 pp., describing the technics required in all phases of still and motion picture photography and photomicrography. General questions such as the planning of departments, the filing and projection of pictures, the preparation of exhibits, etc., are also discussed. Most back numbers are available from the Editor. Microfilm or photoprint copies of individual articles may be ordered through the Secretary.

Each September, the Association meets in a city chosen by the members. These annual sessions, through a varied program of demonstrations, round tables and original papers, offer the beginner an introduction to the field and the advanced worker a review of new developments. Important features are the Technical Exhibit for the display of equipment, and the Salon.

It is important for the biological photographer to know what is currently available, not only for his own sake, but because he may have to give advice on the purchase of photographic equipment to staff members of his medical school, hospital or research center. The Annual Salon of prints, transparencies and motion pictures offers a cross section of the best work being produced in biological photography. Awards are given for entries of outstanding merit. For work of consistent excellence over a period of years, or for valuable contributions to the field, the Association has since 1946 conferred the title of Fellow of the Biological Photographic Association on members approved for advanced rat-

ing by the Board. Other important awards are: for the outstanding biological photographer of the year; for the best paper presented at the meeting; and for the best article in each volume of the *Journal*.

Annual dues are $5.00 including *Journal* subscription. Correspondence about membership should be addressed to the Secretary, Lloyd Varden, Pavelle Color Inc., 533 W. 57th St., New York 19. Correspondence about manuscripts or nonmember subscription to the *Journal* should be sent to the Editor, Louis P. Flory, Boyce Thompson Institute for Plant Research, Yonkers 3, N.Y.

Microfilm copies of the JOURNAL are now available from University Microfilms, 313 N. First St., Ann Arbor, Mich. The JOURNAL will be available on microfilm only in a complete year, that is, the two 1950 volumes will be available sometime after the December 1950 issue is published. Microfilm copies will be made available only to those who have subscribed to the paper edition.

By using microfilm, the library may keep the printed issues unbound and let them circulate for the two or three years of greatest use. The microfilm is supplied on metal reels, carefully labeled, and is, of course, designed to supplant the bulky bound volumes which crowd the space of libraries. Microfilm editions cost about the same as binding a volume.

Films in Review is a new magazine now nearing completion of its first year of publication by the National Board of Review of Motion Pictures, Inc., 31 Union Square West, New York 3. Its editor writes that he will welcome contributions by all who have ideas which they would like to bring to a lay audience which is interested in the general aspects and quality of motion picture production as well as the aesthetic, economic, censorship and international phases of the art and industry. Illustrative material can be used, and 1500 words is the most desirable length of article.

Current Literature

THE EDITORS present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N.Y., at prevailing rates.

American Cinematographer

vol. 31, no. 9, Sept. 1950

New "All-Direction" Baby Camera-Dolly (p. 307) L. GARMES

Shooting 16-Mm Color for Blow-up to 35-Mm (p. 308) C. LORING

New Three-Color Meter for Evaluating Illuminant Quality (p. 310) L. MOEN

Audio Engineering

vol. 34, no. 8, Aug. 1950

Transient Testing of Loudspeakers (p. 9) M. S. CORRINGTON

Imagery for Describing Reproduced Sound (p. 14) V. SALMON

Electronics

vol. 23, no. 9, Sept. 1950

Frequency-Interlace Color Television (p. 70) R. B. DOME

Ideal Kinema

vol. 15, Oct. 6, 1949

Kinema Technique and Equipment in Holland (p. 17) R. H. CRICKS

RCA Discloses Its Colour-Television Method (p. 25)

vol. 16, Feb. 9, 1950

Post-War Improvement in Projector Design (p. 19) R. H. CRICKS

International Projectionist

vol. 25, no. 8, Aug. 1950

Projector Shutters: Design, Performance (p. 5) L. DAVEE

Types of Projection Shutters Now in General Use (p. 8)

vol. 25, no. 9, Sept. 1950

Minimizing Flicker in Projection (p. 5) R. A. MITCHELL

Uniform Screen Light Distribution; Elliptical Reflector Mirrors (p. 13) R. A. MITCHELL

Motion Picture Herald

vol. 181, no. 1, Oct. 7, 1950

Technicolor Change to Reduce Costs Sharply (p. 35) W. R. WEAVER

Motion Picture Herald Supplement

(Better Theatres), Oct. 7, 1950

What About Three-Dimensions? Is It Practical? Is It Coming? (p. 63) G. GAGLIARDI

Proceedings of the IRE

vol. 38, no. 9, Sept. 1950

The Present Status of Color Television (p. 980)

Mixed Highs in Color Television (p. 1003) A. V. BEDFORD

New Members

The following have been added to the Society's rolls since the list published last month. The designations of grades are the same as those in the 1950 MEMBERSHIP DIRECTORY:

Honorary (H) Fellow (F) Active (M) Associate (A) Student (S)

Albert, Harold R., Jr., Production Supervisor, Motion Picture, U.S. Air Force. **Mail:** 16011 Manhattan Pl., Gardena Calif. **(M)**

Arvonio, John, Producer, Director and Sound Consultant, 750 Grand Concourse, Bronx 51, N.Y. **(M)**

Braden, Hillis R., Manager, Audio Visual and Photo Division, Hoover Bros., Inc. **Mail:** 1020 Oak St., Kansas City, Mo. **(M)**

Craven, T. A. M., Radio Consulting Engineer, Craven, Lohnes and Culver. **Mail:** 1242 Munsey Bldg., Washington 4, D.C. **(M)**

Crocker, Leslie C., Motion Picture Photographer, American Television Productions, Inc. **Mail:** 24 Brookwood Dr., Maplewood, N.J. **(A)**

Dunn, Walter E., Head, Purchasing and Maintenance, Century Theatres, 132 W. 43 St., New York 18, N.Y. **(A)**

Faichney, James B., Motion Picture Producer-Director, International Motion Picture Division, Department of State. **Mail:** 36 Violet Ave., Hicksville, N.Y. **(M)**

Fuhlrott, Ruth A., Research Chemist, Technicolor Motion Picture Corp. **Mail:** 8753 Dorrington Ave., Hollywood 38, Calif. **(A)**

Gillette, Dale, Medical Photographer, Cedars of Lebanon Hospital. **Mail:** 429 N. Mariposa Ave., Los Angeles 4, Calif. **(A)**

Golash, Edmund S., Research Laboratory Assistant, Twentieth Century-Fox Film Corp. **Mail:** 9 Second Ave., New York, N.Y. **(A)**

Greene, Edward Jesse, Jr., In Charge, Motion Picture Distribution and Production, Shell Oil Co. **Mail:** 37 Poppy Lane, Hicksville, Long Island, N.Y. **(M)**

Gunst, Margaret J. G., Research Chemist, Denham Labs. **Mail:** 85 Harley St., London, England. **(A)**

Hamilton, Vernon P., Motion Picture Laboratory Manager, Strickland Film Co., 220 Pharr Rd., Atlanta, Ga. **(A)**

Hughes, Hovie H., Motion Picture Producer, Edward Schumann and Associates. **Mail:** 118 W. Johnson St., Madison 3, Wis. **(A)**

Kiel, John P., Engineer, Producers Service Co. **Mail:** 6554 Blewett Ave., Van Nuys, Calif. **(M)**

Knight, Paul, Engineer, J. A. Maurer, Inc. **Mail:** 494 South Ocean Ave., Freeport, N.Y. **(A)**

Kreuter, Adolph C., Artist and Designer, Rockford Paint Manufacturing Co. **Mail:** 304 S. Horace Ave., Rockford, Ill. **(A)**

McNary, James C., Consulting Engineer, McNary and Wrathall. **Mail:** 906 National Press Bldg., Washington 4, D.C. **(M)**

Miles, John R., Designer, John R. Miles Industrial Designs. **Mail:** 4821 N. Sheridan Rd., Chicago 40, Ill. **(M)**

Mills, Lt. Col. Morris H., 4721 N. Chelsea Lane, Bethesda 14, Md. **(M)**

Nafzger, Lester H., Chief Engineer, RadiOhio, Inc. **Mail:** 903 S. Roosevelt Ave., Columbus 9, Ohio. **(A)**

O'Brien, J. F., Theater Equipment Sales Manager, Radio Corporation of America, RCA Victor Division. **Mail:** 245 Crystal Lake Ave., Audubon, N.J. **(M)**

Pangborn, Herbert W., Engineer in Charge of Television, Columbia Broadcasting System. **Mail:** 6512 Orion St., Van Nuys, Calif. (**M**)

Parisier, Maurice I., Communications Expert, 1475 Broadway, New York 18, N.Y. (**M**)

Piscitelli, Marco J., American Television Inst. **Mail:** 1433 W. Flournoy St., Chicago 7, Ill. (**S**)

Queeny, Edgar M., Jarville Studios, Route 13, Mason, Kirkwood 22, Mo. (**M**)

Reese, Warren B., Engineer, Macbeth Corp. **Mail:** 282 Hudson, Cornwall-on-Hudson, N.Y. (**A**)

Romrell, Clarence, Photographic Engineer, Tru-Vue. **Mail:** 1234 Glenhurst Court, Rock Island, Ill. (**M**)

Rota, Luigi, Director, Sociedad Radiotechnica Ecuatoriana. **Mail:** P.O. Box 414, Quito, Ecuador, South America. (**A**)

Sandell, Wesley R., Quality Control Engineer, Eastman Kodak Co. **Mail:** 14633 Killion St., Van Nuys, Calif. (**A**)

Schade, Otto H., Research and Development Engineer, Radio Corporation of America, RCA Victor Division. **Mail:** 32 Francisco Ave., West Caldwell, N.J. (**M**)

Scharf, Erwin, Motion Picture Director, City of New York. **Mail:** 72 Park Terrace West, New York 34, N.Y. (**M**)

Sogge, Ralph H., University of Southern California. **Mail:** 942 W. 34 St., Los Angeles 7, Calif. (**S**)

Thomsen, Jack, American Television Inst. **Mail:** 6554 Stewart, Chicago, Ill. (**S**)

Vadillo, Frank, General Manager, Gran Bazar S.A. **Mail:** P.O. Box 160, Merida, Yucatan, Mexico. (**A**)

Veideman, William R., Service Manager, Photo and Sound Co. **Mail:** 3548 18 St., San Francisco 10, Calif. (**M**)

Viles, Frank L., Engineer, Television Broadcasting, Radio-Television of Baltimore, Inc. **Mail:** 4402 Roland Ave., Baltimore 10, Md. (**A**)

Warner, James G., Motion Picture Technical Adviser, Kodak Ltd., The Mall, Lahore, Pakistan, India. (**A**)

Warren, Dave, Salem College, Salem, W.Va. (**S**)

CHANGES IN GRADE

Balakrishnan, A. V., Graduate Assistant, Electrical Engineering, University of Southern California. **Mail:** 1166$^1/_2$ W. Adams Blvd., Los Angeles 7, Calif. (**S**) to (**A**)

Bent, William W., Field Executive, Boy Scouts of America. **Mail:** 4313 Normal Ave., Los Angeles 27, Calif. (**S**) to (**A**)

Buckner, Ralph E., 1155 N. Sycamore Ave., Hollywood 38, Calif. (**S**) to (**A**)

Horstman, Edward C., Chief Engineer, American Broadcasting Co., Inc. **Mail:** 1630 North Shore Ave., Chicago, Ill. (**A**) to (**M**)

Humphrey, John H., Senior Audio Visual Technician, University of Minnesota. **Mail:** 6634 Central N.E., Minneapolis, Minn. (**S**) to (**M**)

Johnston, Jack H., Freelance Cameraman, 810 N. Highland Ave., Hollywood 38, Calif. (**S**) to (**A**)

Nichols, Ralph M., Editor and Technical Advisor, Bob Jones University, Box 597, Greenville, S.C. (**S**) to (**A**)

Sterling, Lyn, Cinematographer, Bob Baker Productions. **Mail:** 3673 Fredonia Dr., Hollywood 28, Calif. (**S**) to (**A**)

DECEASED

Brawner, Cloyce B., c/o Mrs. Virgie Brickenridge, Tuckerman, Ark. (**A**)

Book Reviews

Photographic Optics, by Allen R. Greenleaf

Published (1950) by Macmillan, 60 Fifth Avenue, New York 11. 197 pp. + 2 pp. bibliography + 8 pp. appendix + 6 pp. index. 81 illus. 6 × 9 in. Price $4.75.

The objective of this book is to supply the photographer with a knowledge of optics. The first six chapters describe the general properties of lenses and their aberrations, and also include the usual general formulas of first order optics. The history and kinds of optical glasses are then covered in 4$^1/_2$ pp. Image formation by small apertures receives half as much space. Lens descriptions, based on Kingslake's classification of patent literature, comprise 64 pp. and two appendixes

of 8 pp. Choosing and testing a lens, focusing, shutters, camera accessories, estimating exposure, perspective, printing, slide projection and stereoscopy are briefly discussed in the remaining 100 pp.

The definitions given are clear and should be helpful to a beginner in this field. A possible objection to the book is that it gives so little information on so many topics. Some of the author's choices will not please many readers. In testing lantern slide and film projectors, for example, he cites one American Standard on illumination and temperature measurement, but makes no mention of another on lens resolution testing. Two pages of the $5^1/_2$ pp. alloted to filters are used for transmittance curves of four filters. Rather than republish these, might it have been more useful to have explained what the transmission of combined filters would be, and how computed, rather than stating that one particular combination would transmit too little light for practical importance?

To have compressed as much in so small a book is a real accomplishment. The material may be adequate and not too technical for a large audience. To the reviewer it seems to have too little information on any subject other than lenses, for more than orientation. Perhaps it will stimulate the reader enough so that he will turn to more complete books.—OSCAR W. RICHARDS, Research Laboratory, American Optical Co., P.O. Box 137, Stamford, Conn.

A Grammar of the Film, by Raymond Spottiswoode

Published (1950) by University of California Press, Berkeley and Los Angeles, Calif. 328 pp. including charts and index, 12 pp. illus. 6 × 9 in. Price $3.75.

A Grammar of the Film, subtitled "An Analysis of Film Technique," will be interesting to the engineer or technician who considers the philosophy of the motion picture. Here is an attempt to set forth the functions of the cinema from out of a somewhat scholastic atmosphere which assumes that the medium's reason for existence is to fulfill an aesthetic ideal. We can understand the author's rather academic pronouncements along these lines when we learn that the text was written in 1933, when he was a student at Oxford.

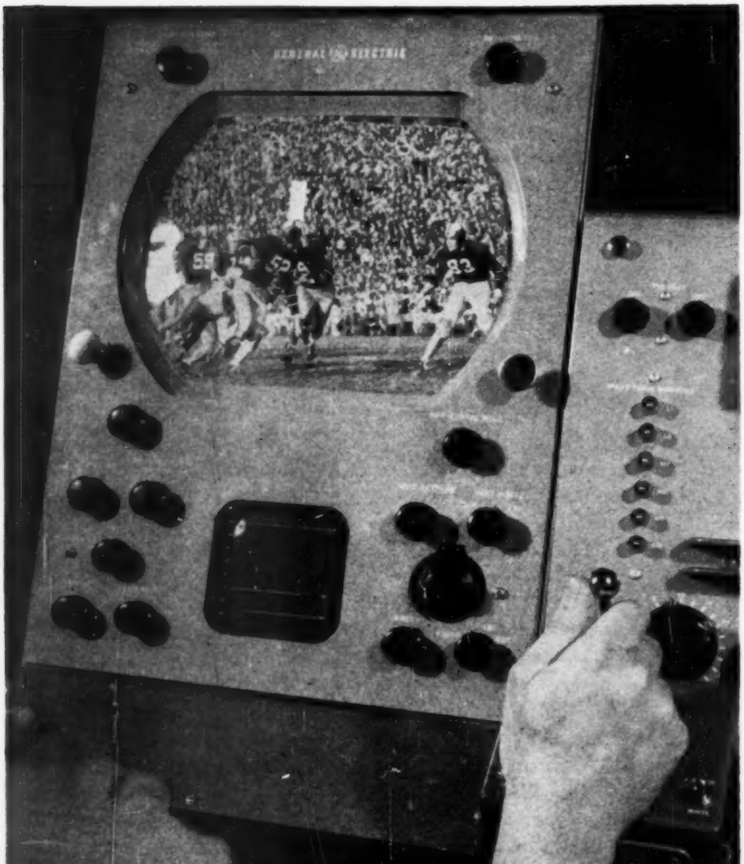
However, since any careful consideration of the film in this aspect is worthy of attention and since the impact of the film on the finer senses ought not to be disregarded, even by engineers, Mr. Spottiswoode's early and later thoughts on what constitutes the foundations and the superstructures of film aesthetics are stimulating, even though sometimes controversial and often obscure.

Here, for instance, the reader may find an extensive discussion and definition of the much-abused term "documentary" as applied to films, the nature and significance of the abstract film, montage and cutting from the point of view of the film's advance as an art form, in addition to many of the author's original theories, with which the reader may or may not agree.

Because of the time at which it was written, some of the discussions are inconclusive and it is interesting to note the actual developments of sound and color in comparison with the author's earlier predictions. The text progresses from definitions to film categories, technique of the film through analysis and synthesis and various critical opinions and polemics.—RUSSELL C. HOLSLAG, Precision Film Laboratories, Inc., 21 W. 46th St., New York 19.

New Products

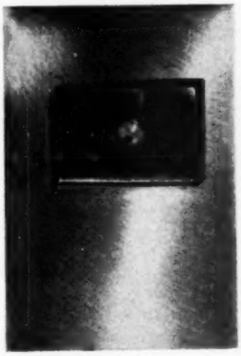
Further information concerning the material described below can be obtained by writing direct to the manufacturers. As in the case of technical papers, publication of these news items does not constitute endorsement of the manufacturer's statements nor of his products.

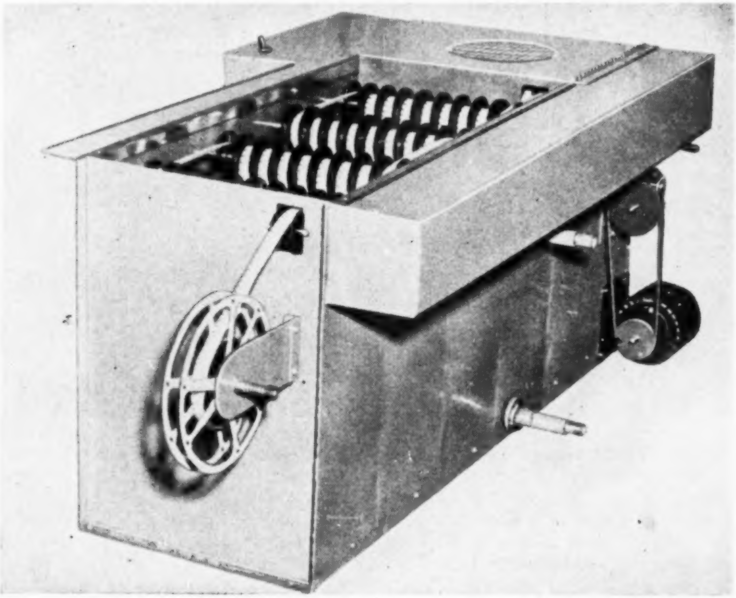


The G-E Electronic Pointer, type TV-34-A, is a new television programming tool consisting of a rack-mounted chassis and a control unit. It permits the commentator to insert a black or white pointer about 30 lines high and 7 lines wide at any point in the broadcast TV picture. The control is similar to the stick of an airplane, and a toggle switch selects either a black or white pointer. Further information is available from G-E Commercial Equipment Div., Electronics Park, Syracuse, N.Y.

Spray-type air washers, humidifiers and dehumidifiers for laboratories, theaters and industrial applications are announced in a new bulletin, No. 7, available from Buensod-Stacey, Inc., at 60 E. 42d St., New York 17, or at P.O. Box 1755, Charlotte 1, N.C.

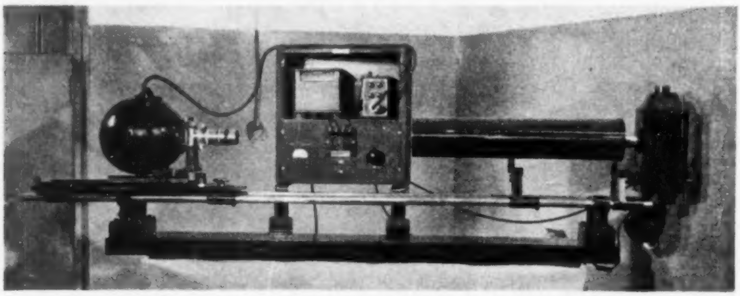
Self-centering film-track pin-hole plates are now on the market, manufactured by Heyer-Shultz, Inc., Cedar Grove, N.J., as an improvement over that firm's pin-hole aperture plates for optical alignment of projectors. The new style plate is designed to be placed in the film path with the positioning block, which is spot welded to one side of the plate, inserted into the aperture opening itself. The plate is made in the 2-in. size illustrated here, for use in all projectors. A 6-in. size has been designed for possible use with different types of projection heads, as described in the manufacturer's instruction booklet.





This automatic 16-mm film processing machine is now marketed by S.O.S. Cinema Supply Corp., 602 W. 52d St., New York 19. It is called the Bridgmatic Jr. and is described as a low-cost model designed for film handling by TV stations, educational institutions and film producers. It is 51 in. long, 21 in. high and 21 in. wide, has patented overdrive, air squeegees, built-in drybox, heating elements and neoprene-lined, steel 2-gal tanks. An hour's output is 600 ft of positive film or 160 ft of negative. One gallon of solution is used in each tank.

The new $f/1.3$, 15-mm Wide Angle Balowstar is now available to 16-mm motion picture camera users from the Zoomar Corp., 381 Fourth Ave., New York 16. It is a 12-element coated lens designed by Dr. Frank G. Back to make photography possible under adverse light conditions. This lens can be used on any standard camera turret without interfering with the fields of the other lenses and, despite its short focal length, has clearance of $15^1/_2$ mm. The design allows use of a conventional short mount, making it unnecessary to remove the lens when the turret is revolved.



"T-stop" calibration of lenses for 8-, 16- and 35-mm cameras in focal lengths of 13-mm to 300-mm ($f/4.5$) is now done by National Cine Equipment, Inc., 20 West 22d St., New York 10. The collimated source method is used, as outlined in "Report of Lens-Calibration Subcommittee," *Jour. SMPE*, vol. 53, pp. 368–378, Oct. 1949. The equipment illustrated employs a photomultiplier tube, d-c amplifier and a series of fixed diaphragm stops as reference standards.

SMPTE Officers and Committees: The Roster of Society Officers was published in the May Journal. For Administrative Committees see pp. 515–518 of the April 1950 Journal. The most recent roster of Engineering Committees is on pp. 337–340 of September 1950 Journal.

Motion Picture Instruction

A new compilation of college and university courses was published in the September *Journal*, to succeed the original report made by a committee under chairmanship of John G. Frayne. Frayne's report in 1946 was welcomed by many and received wide circulation as a reprint.

The new report, compiled in 1949 by Jack Morrison of the University of California, Los Angeles, is now available as a reprint at no charge. Simply ask for copies which you wish to pass on or ask Society headquarters to send them direct to interested persons. Your suggestions about how the data could be made even more useful will be welcomed.

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